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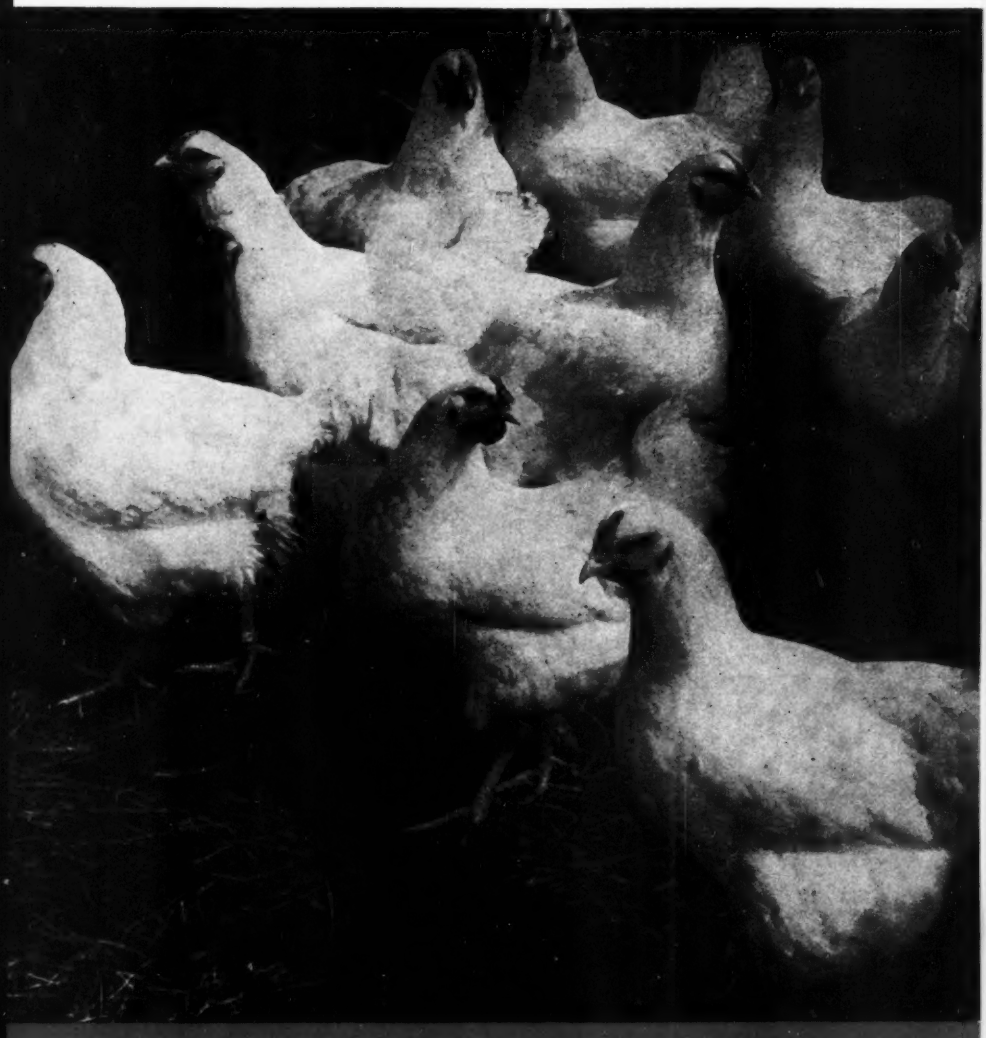

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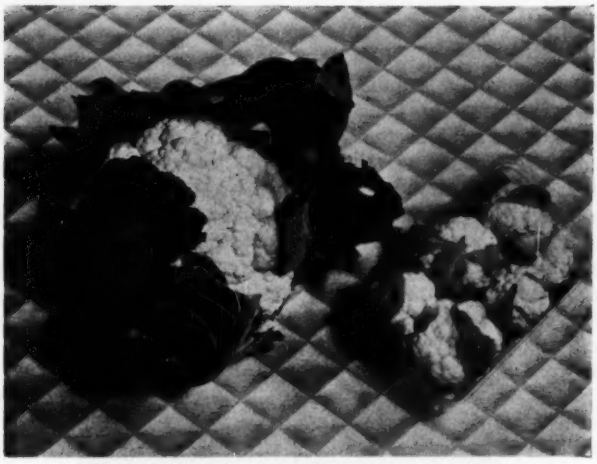


Cauliflowers: the traditional and the mini compared for size

Mini-Cauliflowers

P. J. Salter

Two years ago an idea for the production of miniature cauliflower curds had not been translated into practical terms even on a small-plot scale. Yet in 1971 a conservative estimate suggests that at least 150 acres will be grown commercially. In this article the progression from the original idea to the present situation is described, and possible advantages of this 'new' crop to the growers and its likely appeal to the housewife is discussed. It is not the intention to give technical specifications for growing the crop as information at present available on the subject has been described elsewhere.*

Traditional-sized cauliflower curds cannot be frozen whole because of their individual bulk. They have to be cut into small segments or 'florets' before processing. This is time consuming and expensive and certainly doesn't add to the appearance of the product. Thinking about this situation it appeared that the high labour requirement and trimming losses were among the reasons why processors had not promoted frozen cauliflowers on the domestic market. There was, however, the possibility that if small curds were produced

*A leaflet is available on request from the National Vegetable Research Station, Wellesbourne, Warwick, or from horticultural officers of A.D.A.S.

which could be frozen whole it would almost eliminate trimming, and possibly appeal to the housewife as a ready prepared novelty and to the caterer who would have a built-in form of portion control. At this stage the likelihood of a demand for small curds as a pre-pack on the fresh market was not envisaged.

First experiments

In the summer of 1969 these thoughts led to the first attempt to grow a crop with small-sized curds and a high yield per acre. From experience with other crops it was believed that by reducing the spacing between plants the curd size could be reduced. However, what was not known was whether existing varieties of cauliflower could be grown at close spacing and yet satisfy the three essential requirements of high yield, uniform maturity and high quality curds. With no precedent to act as a guide, arbitrary limits of $1\frac{1}{2}$ to 3 inches in size of curds were fixed as a target for the crop, the upper limit being the likely maximum size which could be frozen whole.

To produce this size of curd very close spacing was believed to be necessary and, accordingly, in the first year spacings on the square of $7\frac{1}{2}$, 9 and $10\frac{1}{2}$ inches between plants were tried, growing the plants, of necessity, on the bed-system. Seven varieties were grown initially, all direct-drilled, of which only one, an early summer cauliflower type, satisfied the three criteria. But the performance of this one variety indicated that the production of mini-cauliflowers, as they were inevitably named, was a practical proposition. The results showed high yields and that over 90 per cent of the plants produced curds between $1\frac{1}{2}$ and 3 inches in size on a single day, with the obvious implication for mechanical harvesting.

Cropping requirements

At this stage discussions with growers, processors and advisory officers revealed much interest in the project and it was decided to expand the experimental work at Wellesbourne and extend it with variety trials at the Efford, Kirton and Stockbridge House Experimental Horticulture Stations of the Ministry. Thus in 1970 investigations were carried out to assess the performance of a further ten early summer cauliflower varieties; to examine a larger range of plant spacings and spatial arrangements; and to determine the fertilizer and possible irrigation requirements, the effect of seed grading on crop uniformity, the correct timing of the single harvest, etc. As a result, sufficient information is now available to make the tentative suggestions in the N.V.R.S. leaflet regarding production.

The essential points can be outlined as:

Crops of suitable varieties must be grown as precisely and as uniformly as possible to ensure that a high proportion of the plants produce a curd within the required size range on the same day and so permit a single harvest to be taken. With the high plant population involved selective harvesting is out of the question.

Because transplanted crops are much more variable in maturity than drilled crops, and because of the close spacing involved (9 x 4 inches is equivalent to 157,000 plants per acre), the crop must be precision-drilled directly into the field and, again because of the high plant population, thinning of the seedlings cannot be economic. Thus, drilling to a stand must be practised. This involves close attention to the preparation of the

seedbed, so that each seed may have similar conditions to germinate as uniformly as possible.

Weed control during the early period of growth is based entirely on pre-emergence herbicides whilst at later stages the crop effectively smothers any weeds.

A balanced type of growth must be achieved because excessive leaf growth tends to result in a more variable crop with poorer quality curds. As a guide, it is suggested that not more than 150 units of nitrogen should be applied to the soil in the base fertilizer and nitrogenous top dressings are unlikely to be required.

Similarly, experimental results suggest that irrigation should be avoided except on the lightest of soils or to encourage quick and uniform emergence of the seedlings.

The correct timing of the single destructive harvest is most important for it has been estimated that a single day's departure from the optimum cutting time can mean a sacrifice of ½ ton per acre or more in marketable yield.

Closely spaced mini-cauliflowers

Present position

The results from experiments have indicated that the higher the plant population achieved per acre, the higher the yield of curds within the size range required. The closest spacing so far used have been 6 x 6 or 9 x 4 inches, but this year even closer spacings will be tried; and the upper size limit of curds has been raised from 3 to 3½ inches following discussions with processors and pre-packers. Within the revised size limits of 1½–3½ inches yields of trimmed curds of over 4 tons per acre were obtained experimentally in 1970 and also when grown on a limited commercial scale, with 70–80 per cent of the plants producing the required size range of curds at a single harvest. If this level of yield and uniformity can be achieved in more extensive trials and on a commercial scale this year, and if the financial return from the crop

is comparable on a weight-for-weight basis with that from traditional-sized heads, then the gross margins would be attractive. However, only very limited economic data on this crop is at present available and it is intended to gather information on this important aspect this year.

At present the crop is cut by hand on a single occasion, a single cut removes the curd and all the leaves are left behind except the bracts surrounding the curd. However, a prototype cutter-elevator machine has been used already at Wellesbourne on this crop with distinct promise, and it appears likely that mechanized harvesting could become routine in the future.

In 1970 a considerable interest in the mini-cauliflower was shown by pre-packers and limited consumer preference trials on the fresh product were carried out. Although it is far too early to assess the likely consumer demand, there were indications that the housewives were very interested in the mini-cauliflowers which were sold in 12 or 16 oz packs containing approximately 5–10 curds of mixed sizes. With the larger quantities which will be available to the public this year a much better assessment of the consumers' reaction will be possible. It should be pointed out that it appears unlikely that curds within this size range will be marketed through traditional markets and, therefore, it is important that arrangements for marketing the produce are made before this type of crop is grown.

If mini-cauliflowers are grown for pre-packing for the fresh market a continuous supply will be required over a long period. If grown for processing the produce will probably be required over shorter periods. In both situations careful timing of each crop will be essential because with this system of production there is no spread of cutting within each crop to help continuity of supply. Also, with these drilled crops, weather and soil conditions will interfere with a sowing programme to a greater extent than with a planting programme. Despite these factors it is believed that continuity programmes can be planned and carried out successfully and work on this subject is being actively pursued in 1971.

Apart from the aspects mentioned already, further detailed investigations are being conducted in 1971 on all factors of production including the control of pests and diseases, the correct timing of harvesting, short-term cool-storage etc. By the end of the year it will be possible to make a much better assessment of the future prospects for this crop.

Pro's and con's of mini-cauliflower

The possible expansion of production of mini-cauliflowers will depend on the relative advantages conferred by the crop to the grower and consumer compared with traditional cauliflowers. It has been mentioned previously that although only two years results are available, this crop is now being tried on quite a large scale and it is interesting to speculate why this has been taken up so rapidly by the industry.

Provided mechanical harvesting proves to be possible, one of the attractions to the grower is the ability to grow this crop without hand-labour being used at all in the field; drilling, spraying and harvesting would be done mechanically and there would be no thinning, top-dressing or inter-row cultivation required. Labour would be transferred to the packing shed in keeping with the general trend. The shorter time required from sowing to harvest to produce the smaller-sized curds and the clearing of the crop with

a single destructive harvest may enable it to fit more easily into crop rotations. There is also a rising demand for vegetables of good quality for pre-packing, and mini-cauliflowers are very suitable for this form of marketing. The crop is most likely to be contract-grown for processor or pre-packer and, therefore, marketing problems may be reduced. At the moment it appears that crops are being grown to gain experience and to find out any problems which may arise.

Against these possible advantages are the problems likely to arise with a crop which must be grown as precisely and as uniformly as possible on a large scale. Undoubtedly, more skill is required to grow uniform crops from drilling *in situ* than from transplants because even emergence and predictable stands are essential. Continuity of supply is likely to be more of a problem than for traditionally grown crops. However, ignoring the profitability of the crop because there is insufficient data to form a judgment at present, it appears that mini-cauliflowers could have certain definite advantages over normal cauliflowers for the grower.

The advantages to the housewife are two-fold: the mini-cauliflower requires no trimming and is a ready-for-the-pot convenience food. There is no waste and thus she is carrying home only what is edible—it is therefore good value if the price is comparable weight-for-weight with traditional sized heads. In addition, the small, whole curds look attractive on the plate and different sizes of curd can be distributed to the family depending on the relative size of their appetites.

In conclusion it must be emphasized that many problems associated with this new crop remain to be solved. However, the experience of the commercial growers who try this crop in 1971 may well be the decisive factor determining the mini-cauliflower's future.

This article has been contributed by **Dr. P. J. Salter** of the National Vegetable Research Station at Wellesbourne, Warwick.

Carbon Monoxide Dangers

Carbon monoxide is a gas which combines with the blood to resist absorption of oxygen, resulting in suffocation. The most likely symptoms of the effect of the gas are tiredness, headache, nausea and palpitation. Death can occur very quickly if a person is subjected to concentrations of this gas.

The exhaust fumes from all internal combustion engines contain carbon monoxide and tests have shown that dangerous concentrations can build up in the atmosphere when rotary cultivators and other petrol-driven machines are used in enclosed buildings which are not satisfactorily ventilated. When machines are used in buildings such as glasshouses or mushroom and rhubarb sheds, adequate ventilation is essential. Growers and operators should make sure that all windows, doors and ventilators are opened before work begins. They should be kept open during work and long enough afterwards to allow the fumes to disperse. Calm, still days should be avoided; better ventilation is obtained when a wind is blowing.

Anyone operating a machine in a glasshouse or similar building should work there for only short periods at a time. Rest periods should be taken frequently, and clearly it is preferable to take these outdoors away from the place of work. Operators should be supervised so that if one of them begins to feel the symptoms of the effect of the gas action can be taken immediately, before he is overcome.

If any operator develops a headache or feels dizzy or sick, he should stop work immediately and go out into the fresh air.

Newcastle Disease (Fowl Pest)

— A Choice of Vaccines

J. I. Davies

On 16th December 1970 the Minister of Agriculture, Fisheries and Food agreed to license Hitchner B1 type live vaccines and thereby added another weapon to the armoury in the fight against Newcastle disease. Since then the poultry keeper has been faced with the problem of deciding which vaccine to use, the live or the inactivated (henceforth referred to as dead). This article would be much shorter, perhaps even unnecessary, if a simple programme could be devised covering all possibilities. Unfortunately this cannot be because there are too many variables, but one very definite statement can be made—EVERY POULTRY KEEPER MUST VACCINATE.

Live or dead vaccine

Dead vaccines consist of heavy suspensions of virus particles that have been inactivated during the manufacturing process. They have no power themselves to penetrate a bird and must be administered by injection into the tissues. This means that they are expensive in labour as each bird must be held for injection; thus vaccinating a house of 20,000 poultry on deep litter is obviously a long and arduous job. Being dead, the vaccines cannot of themselves cause fowl pest, but their usefulness in combating the disease is in no doubt; the incidence of infection in Britain was reduced from over 2,000 cases in each of the years 1963 and 1964 to only 40 in 1969 in a period when only dead vaccines were available.

Live vaccines differ in that they consist of suspensions of living virus particles; they retain the property of invasion and are able to get into the blood stream of the bird without having to be injected. Because of this they can be given by exposing the mucous membranes of the bird to the vaccine, either by mass methods like putting it in the drinking water or spraying it over the birds, or by individual methods like placing drops of suspension on the eye or dipping the beak into a suspension of the virus. Being alive the vaccines do have an effect on the birds; although this is negligible in healthy birds under good ventilation conditions, the application of a vaccine can cause a set-back and, occasionally, mortality if other respiratory conditions like mycoplasmosis are present in the flock. This may be corrected by medication with antibiotics but of course this adds to the expense.

Immunity

What about the immunity dead and live vaccines confer—is there any difference? Both give a similar degree of immunity as measured by blood tests; after a single initial dose this takes about 14 days to develop. Unfortunately it does not last for more than a few weeks and the immunity obtained from dead vaccine wanes rather more quickly than is the case with live vaccine. It must be emphasized that a full course of vaccines is necessary to induce and

maintain a protective level of immunity. When applied for a second time, the response to both vaccines is more rapid and will reach a peak in some 5–7 days after vaccination. Laboratory testing has shown that the level of protection against infection following a second application with the dead vaccine is about twice as great as that following the first application, it fades slowly and will still be at a good protective level for some months. Where this second application is with live vaccine further protection only reaches the same level as it did with the first dose and vaccination has to be repeated every three months. Even if repeated at unnecessarily short intervals dead vaccine will evoke a response and boost immunity. This is not so with live vaccines which, when given at much under three months, will merely 'bounce off'; they have the drawback, then, of having to allow the level of immunity in the flock to slightly fall off before the next dose will 'take'.

Administering vaccine

As a chain's strength lies in its weakest link, so the protection in a flock is dependent on the bird with the lowest level of immunity; for if it becomes infected it will produce virus that will severely challenge the protection of its fellows. It is essential, therefore, that every bird has a full dose of vaccine.

With dead vaccine this is easy—catch every bird and give it an injection. With mass methods of administering live vaccine it is difficult. When using the spray method each bird must be sprayed and the batch should then be left together to allow the vaccine to contact the mouth, nose and eyes as the birds rub against each other, thereby ensuring an even spread. The size of droplet is critical, especially in young birds; too fine a spray will go directly into the lungs and cause trouble and large drops will only wet birds excessively and possibly cause chilling. When vaccine is put into the drinking water, all birds must be deprived of water for up to two hours previously to make sure they drink during the period that the vaccine is present in the water and there must be sufficient drinker space for them all to partake. When it is considered that live vaccine is fragile and can be killed by dirty water, chlorinated water, dirty drinkers and rusty drinkers, it is obviously a highly skilled operation to make sure that every bird gets its dose. Unfortunately, although it is a live vaccine there is little spread from one bird to another and some may not get any at all, even when great care is taken. There is good reason, then, for giving the live vaccine by the individual method of eye drops or beak dipping, especially in areas of high disease risk, but then the greatest advantage of live vaccines—their suitability for mass administration—is lost.

Problems

Principal among the problems of vaccination is the phenomenon of maternal immunity. Breeding flocks that are themselves immune by vaccination or by recovery from natural infection confer a degree of immunity on the day-old chicks which they produce. The duration of this immunity will depend on the level of immunity in the breeding flock. In the case of a breeding flock reaching the end of lay and not vaccinated since point of lay there may be no maternal immunity at all, or it may last for only a few days; but in a breeding flock only just coming into lay that has been fully protected in the rearing stages it may last for a month or more. It is unfortunate that this maternal immunity, besides protecting the young chick from infection, also interferes with the action of any vaccine it is given; so the immunity state of

the parent flock ought to be known before vaccinating the offspring in order to judge the best age at which to apply the vaccine. The complexity of the situation becomes apparent when it is realized that the maternal immunity varies individually from chick to chick and, also, that a large batch of chicks may derive from several breeding flocks of differing immunity status.

Another variable is the location of the birds in relation to cases of infection. Thus the vaccination programme for a flock situated in a region where there is a heavy incidence of disease, or indeed a fresh flock being set up on premises where there was infection in the previous batch of poultry, may well have to be different from that in a district where there have been no outbreaks for some considerable time.

There is yet another factor to be considered. It has been explained that living vaccines gain entrance through mucous membranes. In so doing, they exert a blocking or interference effect on these cells in the nose and throat and respiratory passages that in some way prevents the access of natural virus for some time. The mechanism of this phenomenon is not as yet fully understood, nor do we know how useful it is in withstanding challenge or for how long it lasts. The problem is being studied very closely by the Ministry both in field trials and in the laboratory. Quite obviously it is a desirable property of live vaccines which does not exist at all with dead vaccines.

Vaccination programmes

How, then, does one sum up this very complex situation? The best advice that can be given is that a poultry keeper embarking on a vaccination programme should consult his veterinary surgeon giving him all the known facts, including availability of labour and whether it is intended to vaccinate the flock against other diseases, and by paying due regard to the local disease situation. He should always read the manufacturers' leaflets and follow their instructions about storage and dilution very carefully.

For a simple 'well it cannot do any harm' type of approach (even though it might be wasteful of vaccine) it is suggested that a broiler producer should give a dose of live vaccine as a spray at day old and follow with live vaccine in the drinking water at 14–18 days old and again at 28–35 days old. A rearer could give a live vaccine as a spray at day old and in the drinking water at 21–27 days and again at 7–9 weeks, followed by live vaccine every three months or with dead vaccine at 16–18 weeks and thereafter every six months. A poultry keeper with unvaccinated layers could give a first dose of live or dead vaccine and follow with a dose of dead vaccine after one month and then every six months.

In a district where Newcastle disease is not prevalent and is unlikely to occur, broiler producers could omit the dose of vaccine at day old and the rearer could give either live or dead vaccine at 3 weeks old, again at 8–10 weeks old followed by dead vaccine at point of lay and thereafter every six months. Finally, in a district where cases of disease are occurring a booster with dead vaccine can be given at any time but a booster with live vaccine will only be effective if given when the level of immunity in the flock is waning.

J. I. Davies, M.R.C.V.S., D.V.S.M., is a Divisional Veterinary Officer stationed at Stafford. At the time of writing this article he was dealing with fowl pest at the Tolworth Headquarters of Animal Health Division.

Mechanical Harvesting of Fruit Crops

J. Ingram, *Luddington Experimental Horticulture Station*

THE increasing costs of hand picking and the difficulty in some areas of obtaining enough pickers are the main reasons advancing the need for mechanized harvesting of fruit crops.

The position is most acute with soft fruits for which picking can often account for 50–60 per cent of total production costs. As an example of the increasing costs of harvesting, hand picking of black currants has risen from 1½p to 2½p per lb within the last decade. In addition, the availability of pickers has tended to influence the size and location of production areas and the most suitable soils and sites have not always been fully exploited. These difficulties can be eased to some extent by development of the 'self pick' concept whereby customers are invited to pick the fruit themselves, which is then weighed and paid for on the spot. New plantings are being made with this method in mind but it can be adopted only for limited acreages.

The success of mechanized harvesting of any crop depends on close collaboration between the engineer and the manufacturer in developing the machine, the plant breeder in producing suitable cultivars and the research or experimental worker and grower in devising and adopting suitable growing techniques. Most progress in the development of suitable equipment has been made in the United States due to rapidly increasing labour costs and restriction on the importation of migrant labour.

In Britain the first developments followed the success of the hop picking machines. Work commenced at Luddington on mechanical harvesting of black currants in 1962, and on strawberries, plums and apples in 1968. Since 1968 most of the work has been carried out jointly with the National Institute of Agricultural Engineering, who have been concerned with machine development.

Black currants

There are two lines of approach to mechanically harvesting this crop:

1. Harvesting the fruit from the standing bushes, a method on which development work at Luddington is currently being carried out.
2. Destructive harvesting, which entails cutting the bushes partly or completely down; this method is already in commercial use.

HARVESTING FROM STANDING BUSHES

Most growers prefer this method because bushes remain intact to crop

again in succeeding years. The engineer has been faced with a difficult task in trying to remove fruit in this way as the strig does not readily part from the shoot, nor the berries from the strig. The forces required to do this resemble those that remove leaves or cause shoot breakage, which reduces the crop in the following year.

In a trial at Luddington to determine the effect of leaf removal at harvest, the bushes which had all their leaves removed carried only a 10 per cent crop in the following year; those where half the leaves were removed carried a 50 per cent crop. Defoliation of black currants at harvest has this effect since the flower initials for the following crop are being formed at that time. Machines for harvesting must, therefore, remove the minimum amount of leaf.

The most widely grown black currant in Britain is the cultivar Baldwin and one of the reasons for it being grown so extensively is that in addition to heavy cropping its fruit 'hangs well', an important requirement for hand picking. Plant breeders are now selecting for cultivars which can be more easily harvested by machine. The cultivar Magnus has proved to be very suitable for mechanized harvesting in New Zealand as it is more easily removed than other cultivars. This cultivar is now being compared in trials at Luddington.

It is possible to use a spray application of ethrel to reduce the force required to harvest black currants. The effect of this is to release ethylene which induces fruit abscission and hastens ripening. Comparisons made at Luddington in 1969 and 1970 showed that the effect of ethrel was closely correlated to the concentration applied. Three days after an application of ethrel at 500 p.p.m. the force required to remove fruit was half that necessary with untreated bushes. While ethrel may be a useful aid to harvesting by machine or by hand, there are difficulties in getting through a plantation to spray just before harvest. At the present time it has not been cleared for application on black currants any later than two weeks before harvest.

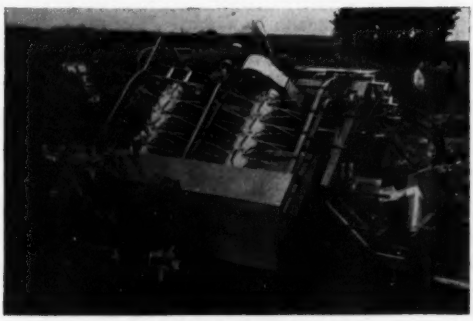
Use of ethrel on black currants in July. Bush on left had no application at all and branches have been shaken once. Bush on right had 1,000 p.p.m. ethrel applied and photograph shows result of branches being shaken once three days later

The machines at present being developed for harvesting black currants from standing bushes are:

N.I.A.E. machine. A self-propelled unit was produced by the N.I.A.E. to determine the frequencies and amplitudes of vibration necessary to harvest black currants from standing bushes, and to establish the design

requirements for a prototype harvester. The 1970 machine incorporated two freely rotating vibrating drums fitted with radial tines which engaged with the bushes and an inertia shaker on each drum to generate vibrations at frequencies of up to 1,400 cycles per minute (photograph below). The machine divides the bushes down the centre and working on the half nearest to it inclines the branches over at an angle of 45° and shakes them over a collecting conveyor. Test runs on the cultivar Wellington XXX in 1970 showed a mean fruit removal of 63 per cent at a frequency of 600 cycles per minute increasing to 90 per cent at 800 and 99 per cent at 1,000. The amount of leaf removed was acceptably low, ranging from 2·7 per cent at 600 to 5·5 per cent at 1,000 cycles. Frequencies of 1,200 and 1,400 increased leaf removal to 11 per cent.

The first test rig was produced in 1968 and the success achieved in 1970 has led the National Research Development Corporation to negotiate for the commerical manufacture of a prototype harvester based on the principle of the N.I.A.E. unit. They will be designed for three point linkage tractor mounting and will be driven by a hydraulic pump mounted on the tractor p.t.o. shaft.

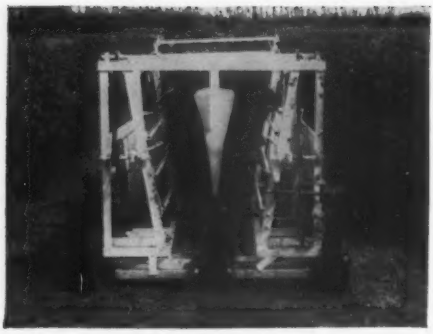


N.I.A.E. black currant machine

Experience with the machine in 1970 showed that it worked satisfactorily in existing conventional bushes but that closer spacing of the bushes in the row (which induces more erect shoot growth) improved the performance. Double rows and other planting systems have been established at Luddington to see whether more suitable growing methods can be adopted.

Appleton machine. This harvester, first demonstrated in 1969, has been developed by P. M. Appleton, of Bowley, Hereford. It has been designed primarily for harvesting fruit from the part of the bushes remaining after removal of the three-year-old wood for destructive harvesting by the Bruff machine. The harvester is fully mounted on a tractor and comprises two plucker assemblies and a suction fan to remove leaves. The plucking units are similar to those used in hop picking machines and work upwards from the base of the bushes on each side of the branches. The use of hop-type plucker assemblies does tend to remove a fair amount of leaf.

Levin machine. A machine for harvesting fruit from short term cropping closely spaced black currant bushes. Produced at the Levin Horticultural



Levin black currant harvesting machine

Centre in New Zealand it has reached the stage when it is claimed a commercial prototype can be built (photograph above).

Harvey blueberry harvester. A standard Harvey blueberry harvester was successfully used to harvest black currants in the Niagara peninsula of Canada in 1969 and a smaller machine, primarily intended for the harvesting of coffee and grapes, has now been developed.

The progress being made suggests that mechanized harvesting of black currants from standing bushes will be a commercial reality within the next few years, by which time the most suitable growing techniques should have been decided.

DESTRUCTIVE HARVESTING

The unsuccessful attempts that were made in the early 1960s to harvest black currants from standing bushes led manufacturers of hop picking machines to develop machines for a similar destructive harvesting technique on black currants. This resulted in the Bruff harvester being first demonstrated in prototype form in 1963 and the Hinds combine machine in 1967. Both are now used commercially.

The Bruff method is to cut all the three year old branches from the bushes and, using a carpet haulage system, to convey them to the static harvesting machine located on the headland. The remaining fruit on the bushes is hand picked or harvested by the Appleton machine.

The Hinds machine works as a combine, cutting the branches at ground level, elevating them for plucking and then shredding them before they are fed back on to the land. The fruit is fed into trays. A system of biennial culture has to be adopted for the Hinds machine as the bushes crop only once every two years. Two equal areas are required in any year, one in the fruiting phase and one in the growing phase.

While destructive harvesting has been adopted by a number of black currant growers, the harvesting of fruit from standing bushes offers greater promise of more effective harvesting by machine.

Strawberries

The method of harvesting strawberries at present being investigated by the N.I.A.E. in collaboration with Luddington are once-over systems which pose the need for a sequence of cultivars which ripen their fruit over a short period; together with growing techniques such as cropping only on one year

old plants planted in single rows at close spacing in the row. The N.I.A.E. work on this crop commenced in 1968 and although a new experimental machine is being built for trials this year further development is likely to be needed before a commercial machine can be envisaged.

In North America at least six strawberry harvesters are under development at experimental stations. All employ the once-over harvesting system but unlike the N.I.A.E. approach most are based on a combing mechanism.

Raspberries

Raspberries are already being mechanically harvested successfully in the United States and the shaking mechanism is so sensitive that it removes only the ripe fruit, permitting successive traverses by the machine during the full ripening period. One of the American machines, the Agricultural Sciences harvester, was imported into Scotland in 1970 for trial by the N.I.A.E. Scottish Station and the Scottish Horticultural Research Institute. Preliminary results showed that fruit was more difficult to remove than in America, possibly because of cooler climatic conditions here. Two other harvesting machines have been under development in Scotland.

The acreage of raspberries in Britain, excluding Scotland, has fallen considerably because of the difficulties and cost of hand picking; mechanized harvesting could help to restore production.

Gooseberries

It is possible with some modification of the machine and cultural methods that gooseberries could be harvested by the N.I.A.E. black currant machine. This, however, requires investigation.

Bruff static black currant harvester showing plucked branches at left after passing through machine

Plums and damsons

Some commercial harvesting of the plum cultivars Purple Pershore, Victoria, Blaisdon Red and Shropshire Prune damson for processing has been done in this country using a trunk shaker and fruit catching unit. The jaws of the inertia shaker are rubber-cushioned to avoid trunk damage and a shake of only a few seconds is required to remove the fruit. To more closely match the speed of operation of the shaker a more effective and cheaper catching unit that will lead the fruit into boxes or bins is required. The

N.I.A.E. have been investigating the extent and causes of fruit damage and when this aspect of their work is completed hope to go on to develop a more effective catching system.

The use of ethrel on damsons to ease fruit abscission has led to severe gumming from branches and to delayed flowering and crop reduction the following year. The trunk shaker can effectively remove the fruit but ethrel might have enabled harvesting to commence earlier.

A trunk shaker at work

Apples and pears

The harvesting costs of apples and pears represent only about 15 per cent of production costs. Because of this, and the comparative efficiency of hand picking, the incentive to mechanically harvest is not as pressing as with the soft fruits. Work on the development of trunk and branch shakers with collecting frames for harvesting apples is being actively pursued in the United States and elsewhere, but the greatest problem is to avoid damage to the fruit as it falls through the tree and on to the collecting frame.

In this country the Worsfold apple picking unit was introduced in 1968; this comprised hand-held branch shakers actuated by compressed air, and the fruit was collected in a tarpaulin covered frame. The unit was used on Bramley trees in Kent but the same problems of bruising occurred.

For the future, Long Ashton Research Station are investigating the possibility of growing apples on a 'meadow orchard' system where very closely planted trees are cut down for harvesting and grown on for further successive destructive harvesting. This concept was described in an article by Professor Hudson in *Agriculture*, April 1971.

Assisted hand picking is another approach to the harvesting of apples and pears and the N.I.A.E. have produced prototype motorized picking platforms provided with conveyors to carry the fruit from the pickers into bulk bins. The platforms can be used only in narrow hedge-type plants.

In conclusion

The problem of mechanically harvesting black currants appears to have been resolved and future developments are likely to enable raspberries, gooseberries and strawberries to be harvested for processing. With tree fruits the tree shaker may be of value for harvesting some plum cultivars and possibly acid cherries and culinary apples but complete mechanical harvesting of dessert apples, pears and plums for the fresh fruit market is less likely.

Revegetation of Derelict Land

Alun Rogers

WHEREVER possible, derelict reclamation schemes try to provide the maximum area suitable for beneficial post-reclamation development by either industry or housing. Although there may be a substantial proportion of the land incapable of economical development, such schemes can provide a much needed and perhaps overdue improvement to the visual amenities of the surroundings, at the same time creating many of the facilities envisaged by the Countryside Act.

Whether or not a scheme has a purely amenity end product, considerable areas of reshaped land will need to be clothed with vegetation. This is desirable not only for aesthetic reasons, but also to eliminate the considerable scouring and erosion of the restored surfaces which could otherwise occur.

Areas of un-reclaimed industrial dereliction are obtrusive. This is due partly to the unnatural land shapes created by industrial operations and partly to the absence of vegetation caused by an insufficiency of soil and humus. The engineering operations involved in reclaiming derelict land can remove an unsatisfactory land form, but the deficiency in the soil raises many problems when revegetation satisfactorily to grass or tree cover is desired.

Establishing grass cover

The absence of soil cover on derelict land and the vast areas involved make the normal soil stripping of a site prior to engineering operations and respreading on the reformed area impossible. Hence the traditional prerequisite to the sowing of grass seed of providing and spreading suitable soil is economically prohibited.

Over the past decade various methods of revegetating areas deficient in soil and humus have been developed. In the main these have been 'hydraulic seeding' techniques by which a mixture of seed, chemical fertilizer and humus (in the form of chopped straw or wood cellulose) is spread on to the reformed area. This type of operation has proved satisfactory for the initial establishment of vegetation; but experience has indicated that unless the restored areas are regularly treated with further applications of chemical fertilizers, there is a marked deterioration in the standard of vegetation established after the second or third year.

During 1959/60 the State University of Georgia carried out extensive experiments on the use of organic type fertilizers for the vegetating of waste land. Later, 1966–69, experiments were carried out in conjunction with the Ministry of Agriculture, Fisheries and Food on the revegetating of colliery and ironstone shale. These experiments also used an organic fertilizer based on natural broiler house litter, and they culminated in a series of trial plots

at Treorchy and Tredegar on which various proportions of chemical fertilizer were used on some plots and varying rates of organic fertilizers on others. In both sets of experiments the results obtained from the organic fertilizer proved extraordinarily successful in comparison with chemical fertilizers.

One of the organic fertilizers used on the M.A.F.F. trial plot is provided by Land Reclamation and Improvement (Wales) Limited of Llanishen, Cardiff, under the registered name 'Chiguano' and is the basis of the re-vegetating service used extensively in South Wales. It is a comparatively dry organic fertilizer containing 2·2 per cent Nitrogen, 2 per cent Phosphate, 1·3 per cent Potash and 25 per cent water; the remaining 70 per cent is a natural humus. Spreading, which has been done on slopes as steep as 1 in 3 with suitably adapted machinery, is at a rate of 5 tons per acre; this provides the basic nutriments of 240 units Nitrogen, 225 units Phosphate and 145 units Potash.

The main advantages of using an organic fertilizer on shales, which are extremely deficient in humus, are:

- a marked overall improvement of the soil structure by the addition of a natural humus;
- the rapid establishment of micro-organisms in the soil which increases the build-up of humus;
- the provision and slow release of nutrients, especially Nitrogen, essential to plant life (on the experimental plots this advantage is becoming very apparent by the continued improvement of the turf in the second and third years without any further treatment);
- the neutralization of substances that tend to be toxic to plant life; there are numerous other unknown and as yet little understood properties present in this type of organic fertilizer, all of which encourage and promote plant life.

Seeding

The seed mixture used in South Wales is mainly of certified British strains of perennial Ryegrass, Timothy, Creeping Red Fescue and Wild White Clover. Rate of spread varies from 35 lb per acre where there is both shale and sub-soil to 50 lb per acre on areas entirely of shale. The seed mixture is uniformly spread then top dressed with the organic fertilizer (at 5 tons per acre) and the area is then rolled.

For slopes up to a steepness of 1 in 3, the seed mixture and the organic fertilizer is distributed by spreaders. For aesthetic and stability reasons no slope should exceed 1 in 3 and preferably should not be steeper than 1 in 5; but where special reasons require slopes steeper than 1 in 3 to be seeded in preference to tree planting, the seed mixture would be applied by hand and the organic fertilizer by using a blower.

In order to ensure that the freshly sown areas are protected against animal grazing until the root formation is sufficiently established, it is necessary to erect a temporary form of stock-proof fencing around the reclaimed land for about 12 to 15 months. After that it is equally as essential that the new grass should be regularly grazed.

For most of the areas of dereliction in South Wales, the period for grass seeding should be confined to between mid-April and mid-August because of the elevated and exposed nature of the sites. However, in exceptional cases where the land reforming is not completed until early September and where,

due to the steepness of the ground, there is an exceptional risk of scouring during the coming winter, seeding can be carried out up to the end of September provided it is appreciated that growth failures may occur on parts of the areas.

In using the organic fertilizer in South Wales, where in 1970 land was reclaimed on exposed sites at elevations between 1,000 and 1,200 ft, two peculiarities were noticed:

a. On a site of 72 acres at Pant-y-Fforest, Ebbw Vale, where there were considerable areas with slopes of 1 in 4 and steeper, very heavy rainfall occurred immediately after the areas had been treated. It was anticipated that on the steeper parts of the site the organic fertilizer and seed would be washed away. However, surprisingly little damage was caused, apparently due to the fact that the wet organic fertilizer has an adhesive quality which fixes the seeds to the shale.

b. When the organic fertilizer is stored on site prior to spreading, oxidization often gives rise to a strange but noticeable smell which disappears within 24 hours after spreading. The odour is completely non-toxic and is quite harmless, but if the material is stored near residential development complaints of smell can arise. This occurred at Blaina and at Pant-y-Fforest, but was of very short duration; the occupiers of the houses which previously looked out onto the derelict area are now unanimous in their praise of the vegetation which was so rapidly established.

Tree planting

On most areas of reclaimed land it is desirable to provide copses of trees to improve the visual amenities and also to give shelter to animals. The absence of normal soil coverage and the extreme deficiency in humus provide such an unsatisfactory planting medium that the choice of tree types is considerably restricted and there can be a large proportion of failures.

Many existing areas of dereliction are close to sites of modern industry, which causes some amount of atmospheric pollution. A high degree of atmospheric pollution will prohibit tree planting while a lesser degree will again restrict the choice of trees.

The criterion for tree planting on reclaimed derelict land is the improvement of visual amenity rather than the growing of an economical tree crop. Therefore, the maximum use should be made of indigenous deciduous types, with conifers and evergreens solely to provide a vestige of winter greenery. A further reason for using deciduous trees, of equal if not greater importance than improvement of visual amenity, is the annual build up of much needed humus in the low grade shale and sub-soil provided by the annual leaf fall. Also, in industrial areas they are more resistant to atmospheric pollution than conifers.

The following types of trees, the majority of which are indigenous to the South Wales valleys, are suitable for humus deficient colliery shale and clay sub-soil and for exposed sites:

Hawthorn (*Crataegus monogyna*)
White Birch (*Betula pubescens*)
Rowan or Mountain Ash (*Sorbus aucuparia*)
Sycamore (*Acer pseudo platanus*)
Sessile Oak (*Quercus sessiliflora*)
Alder (*Alnus incana*)
Lodgepole Pine (*Pinus contorta latifolia*).

Trees for planting out should not be large, partly for economic considerations of initial and replacement costs but mainly because a sturdy young tree is more likely to adapt itself to a change of ground than an older, more

established tree. They should normally be planted out at 5 ft centres (1,742 trees per acre), a density which allows for a reasonable number of failures. As soon as the foliage canopy has been established, i.e., the branches of adjoining trees meet, the plantation can be thinned out, the thinnings being used to establish more mature copses on other reclaimed areas. The more mature trees will have become well adapted to the barren shale.

Planting should be carried out between October and the middle of March, but only when weather conditions are suitable. On no account should it be done while the ground is frozen or covered with snow. The trees used should be small, well grown and healthy seedlings which have been one year in the seed bed and one year transplanted. Every care must be taken during the movement of the plants on to and about the site to ensure that they are protected from possible damage. On no account must their root system be exposed to wind or sun prior to the actual planting operation.

Holes of sufficient size to accommodate the root system of each seedling are made and each transplant is firmed in so that its root system is covered to the same depth as when in the seed bed. When the ground or weather conditions indicate watering is necessary, it should be done immediately, firming in.

Research into maintenance of grassed areas

While the problem of initiating vegetation on soil-deficient areas may have been largely and satisfactorily solved, much work remains to be done in investigating economical methods for the maintenance of the vegetation. In South Wales, a programme has been started which involves survey and experimental work into the vegetation of coal and ironstone mine waste.

Briefly, the surveys will be of the natural vegetation of coal measures soils and revegetated coal tips to analyse the nutrient, acidity and other characteristics of the soils; and to study and assess soil-surface stability and general plant growth potential in reclaimed areas.

The experiments will be carried out on statistically designed trial plots to test out the interaction of various grass and tree species in varying situations and conditions. Comparisons will be made between local seedlings and commercial varieties for growth potential and there will be trials to establish the feasibility of rapid vegetative propagation and, where possible, perhaps grazing trials in conjunction with local farmers.

It is hoped that this exercise will fill a number of gaps now existing in information available and will enable a supply of indigenous wild grasses to be available at economical cost. The use of these may well substantially eliminate the need for continual maintenance of reclaimed areas.

The author, **Alun Rogers, M.B.E., B.Sc.(Hons.), M.I.C.E., M.I.Mun.E., M.I.Struct. E., M.I.H.E.,** is the Land Reclamation Officer of the Monmouthshire Derelict Land Joint Committee.

Land Drainage

Ditching work in progress preparatory to comprehensive under-drainage

This feature, on aspects of land drainage, contains articles by:

- ★ **E. T. Belding, A.I.Agr.E., who is a Senior Drainage and Water Supply Officer with A.D.A.S., London.**
- ★ **J. Rowland Smith, M.B.E., A.R.I.C.E., who is a senior Drainage and Water Supply Officer with A.D.A.S., Ely.**

Drainage Survey in England and Wales

E. T. Belding

THE records have it that in the mid-nineteenth century Bailey Denton, the Engineer to the General Land Drainage and Improvement Company, was the first to try to assess the drainage conditions of the agricultural land in this country. That he did so seems to have stemmed from his fanaticism for 'draining', together with a unique experience of national drainage problems gained through his work as principal engineer. Also, being a far-sighted man, it is more than likely that his aim was to influence Government policy on land drainage matters.

In addition to his wide personal knowledge and experience, Bailey Denton's survey was based on geological formations, information from Government returns and details obtained from yearly pipe sales. In his findings he took the agricultural land in England and Wales to be 32·6 million acres. He estimated that 3 million acres had already been drained, 14·1 million he classified as dry land and peat fen, leaving 15·5 million as being in need of attention. These assessments he gave to the Lords Commission on Agriculture in 1880. When further questioned about his staggering figure of 15·5 million acres needing improvement he said he was sure that of this at least 7·5 million would be very well worthwhile draining. His estimate of cost for such a drainage effort was around £50 million.

Although in his evidence to the Commission Bailey Denton said that three million acres had been drained to a satisfactory standard, an examination of his records tends to show that this was a very low estimate. If the pipe production figures given for the year 1855 are taken as being broadly representative of the period 1840–90 then on this basis it is probable that nearer 10–12 million acres were drained to a reasonable standard.

Ministry enquiries

In the late 1950s the Ministry of Agriculture, Fisheries and Food carried out a comprehensive drainage enquiry. This was founded on counties subdivided according to the surface geology. All areas were visited and an assessment of the drainage conditions was made based on discussions with local agricultural and drainage staff and an examination of grant records. The results were not published but it was estimated that some 14 million acres were in need of drainage improvement.

As part of 'market research' for management purposes, and in recognition of the increasing demands on the soil by modern farming, the Ministry carried out a further survey in the winter of 1968/69. There was a need to update the existing information on the drainage condition of the present-day total of 27·2 million acres of agricultural land in England and Wales.

This survey was based on a 5 per cent sample and involved the classification of all the agricultural land on each of 301 ordnance survey six-inch maps which had been selected at random (Fig. 1). In all, about 1·4 million acres were surveyed and allocated to a category according to drainage conditions.

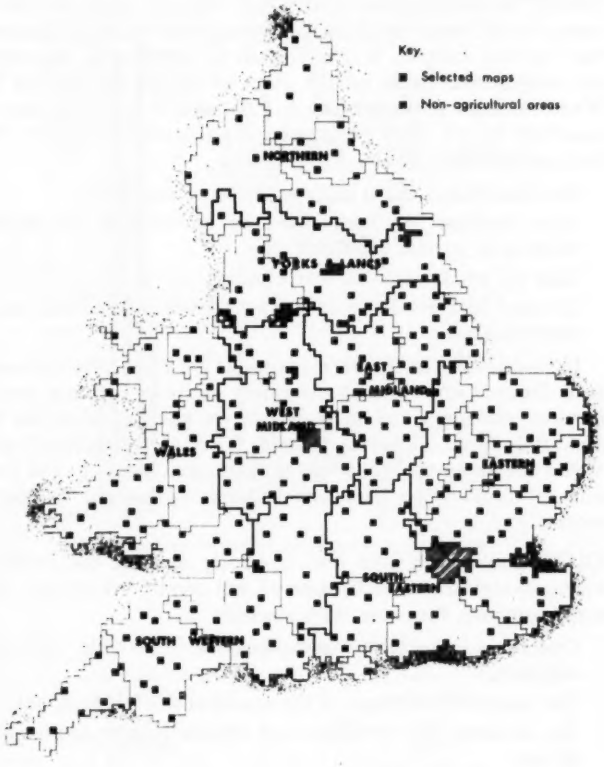


Fig.1. Location of regions and the selected maps.

Again, the classification was based on geological formations, and drainage officers made a field by field study of each formation and assessed the drainage conditions they found. To clear up doubtful points farmers and N.A.A.S. District Advisers were consulted on farming practices, cropping etc. Altogether five categories were used:

1. GRANT—This comprised land adequately drained with the help of grant aid since 1939 and is a factual record.
2. GOOD NATURAL DRAINAGE—This category describes natural free draining soils such as those lying on chalks and well fissured limestones where characteristically few open ditches are to be found.

3. OLD—Land given this classification is known to need artificial drainage for good farming and is still being effectively drained by systems laid before 1939. To warrant this assessment, and to differentiate it from the good natural drainage category, there has to be a clear inference that underdrains are responsible for the well drained condition of the land.

4. IMPROVE—This covers land which relies on artificial drainage but where the drainage condition is at present sub-standard. In considering land for this category it is important to compare its use with that of the well-drained fields on the farm or on similar land in the area. Where a more profitable use is envisaged it must be one which is practised by the more progressive farmers of the district. The main tests applied were:

   Drainage works could be expected to be successful;

   After drainage the land could be included in the normal crop rotation or a more profitable one;

   That the work would be worthwhile;

   It would be carried out by a good farmer as a normal businesslike improvement.

   If, in addition to the above criteria, the successful drainage of the land depends upon the improvement of rivers or main watercourses (arterial drainage) and work is not yet planned, then the land was separately listed. Generally arterial drainage systems in England and Wales are well attended to by the drainage authorities and only about one per cent of the land surveyed was considered to need arterial works.

5. OUT—This covers land that is poorly drained but unlikely to be economically drainable because of soil conditions or lack of agricultural potential. Five tests were applied:

   Operational obstacles made the work impossible, difficult or too expensive;

   The successful outcome of the remedial work is in doubt;

   The location, soil conditions, or climate impose serious limitations of use;

   That the land is likely to be lost to agriculture in less than ten years;

   Any proposals are unlikely to pass the prudent owner-occupier test.

Evaluation of results

On completion of the survey field-work the individual map results were processed and raised statistically (for this a computer was used) to produce national and regional figures. Inevitably, with only a 5 per cent sample, some tolerance must be accepted on the raised results. The national figures are accurate to within $\pm$ 10 per cent and the results give a good picture of the drainage conditions of the agricultural land of England and Wales. The regional figures are within $\pm$ 30 per cent and are not so statistically reliable. Nonetheless they give a fair indication of the drainage situation in the regions.

Simplified figures for the national situation are given in Table 1 and full national and regional results are shown diagrammatically in Figure 2.

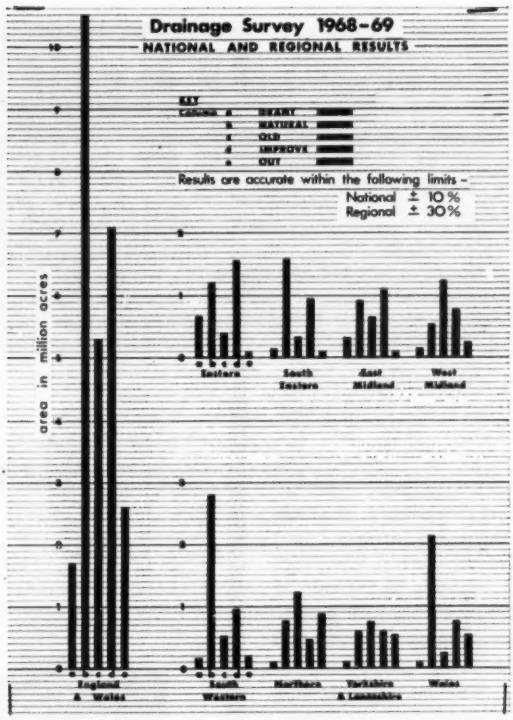


Fig. 2 Full national and regional results of drainage survey

Table 1 **Drainage survey 1968/69**

Land classification (as defined above)	*Estimated area million acres*
Grant	1·7
Natural	10·5
Old	5·3
Improve	7·1
Out	2·6
Total	27·2

Compared with the earlier Ministry enquiry these results give a much lower figure for the acreage in need of better drainage. It is interesting to note that H. H. Nicholson in his book *Modern Field Drainage* published in 1943 mentioned a National Farmers' Union enquiry of the 1930s which indicated a figure of 7 million acres of land likely to benefit from field drainage.

The 5·3 million acres in the 'old' category is significantly large. The survey shows that much of the land still drained by these old systems is to be found in the north and west of England. The continued effectiveness of old works in these areas is possibly due to the steeper sloping ground and more stable clay soils, coupled with the fact that the predominant crop is grass which helps preserve soil structure. The rate of underdrain deterioration is generally

much quicker in the silty arable areas of eastern England. Consequently the acreage served by useful 'old' drains is proportionally lower on that side of the country. From the estimated total of 10–12 million acres drained during the 'Golden Age of Agriculture' (1840–1890) it is not unreasonable to find that over 5 million acres of these old systems are still in working order.

Dependence on drainage

The results apart, all the surveys indicate one significant point which is that something over half the agricultural land in England and Wales depends on artificial drainage for the efficient production of crops and grass. Present-day farmers know this and as a result the last few years have seen a quickening in the rate of progress in laying down new underdrainage systems and the 200,000 acres drained with grant aid in 1970/71 may well be approaching the all time record of the last century.

On the wetter lands drainage is readily acknowledged as an essential starting point for improvement in farming and it is most desirable that the rate of work should go on steadily increasing.

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Comparison between poorly drained land in the foreground and well drained land in adjoining field

Identifying Drainage Need

The Value of Comparisons

J. Rowland Smith

It is a fundamental concept, as well as an economic necessity, that every acre of the farm must pay its way and contribute its share towards making a living and paying the rent. The old adage might well be adapted to 'Look after the acres and the farm will look after itself'. When, for example, comparisons are made, the unit used is the acre and we speak of the yield per acre or rent per acre. What needs to be done is to take this concept to its logical conclusion and positively identify the particular fields on the farm which do well, and the others from which results are sub-standard. The next step is to find the reasons for the differences; these can be one or many and the farmer may need expert help in identifying them. All too often it is found that a field with good drainage yields say 37 cwt of cereals per acre while a poorly drained field on similar soil is difficult to work and the yield is only perhaps 20-23 cwt per acre. If the major differences can be identified as one of drainage then the comparison shows what is being lost due to poor drainage and also that the cost of correcting this is easily recoverable.

Breakdown of existing drains

It is estimated that about half the fields in England and Wales require the installation and maintenance of artificial drainage systems if full agricultural use is to be obtained. It is likely that some 12 million acres of these were drained during the nineteenth century, but many of the systems have now ceased to function although a recent sample survey indicated that about 5 million acres are still effectively drained. All systems of underdrainage, however, do eventually break down or become choked with silt and need to be replaced.

The breakdown of an existing system is often very gradual and may spread over a number of years, its declining effectiveness being disguised by wet and dry seasons, and it may not be possible initially to identify clearly the cause of the trouble. Nevertheless, a point is eventually reached when there is little doubt that the field gives a performance below that of well drained land of similar soil type. At this point in time action needs to be taken if the field is to be restored to full use.

In the case of an arable field the decisive point is reached when the field is found to be 'late', or dirty, difficult to cultivate or to harvest, and is giving disappointing yields. In these circumstances, the farmer often decides that he can no longer sow a particular crop as part of his farm rotation. Alternatively, he may have no other convenient use for the land and may continue to persist with the same rotation, accepting the hazards and reduced yields which can lead to really heavy losses in particularly wet seasons.

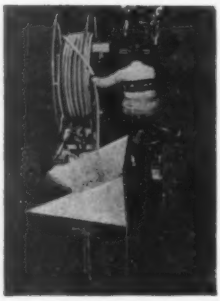
On grassland the critical point is not so sharply seen, but if careful comparisons are made with well drained land it will be clear that the inferior field is late in spring, more easily poached, and that the quality of the sward is poorer; also, the eradication of water-loving plants and rush infestations are more difficult. In a recent trial in Devonshire the difference between a well drained field and a poorly drained field of the same size averaged eighty grazing days per acre annually.

So much is to be gained by comparing results from well-drained fields with those having poor drainage. If there is any difficulty in making such comparisons within the one holding then an exchange of information with a neighbour on similar land can be useful, particularly if the

Trenchless drainage:

the breakthrough

Several prototype drainage machines which could lay plastic pipe without digging out a trench were seen in action at the National Spring Demonstration four years ago. Now there is a national network of drainage contractors with seasoned teams and a lot of trenchless drainage experience behind them, using what is now the leading machine, the McConnel TG1. Senior Ministry of Agriculture officials have welcomed the trenchless method because it can lay drains quickly and at reasonable cost.



The days of open drainage trenches are numbered. Why? Instead of land drainage creating a major disruption of farming operations, with subsequent cultivations, all that you see when a trenchless drainer has passed is a neat slot and a slight mound. Both settle down again, this can be helped by running a tractor wheel above the newly-made drain. What you do not see is that the ground has been fissured as far away from the drain as 6ft. This subsoiling makes cracks which drain off surrounding water to the new drain.

Very little mess means that you can put down drains by this method as late as May in sown crops provided reasonable care is taken.

Infertile subsoil stays below ground. Nothing is dug up so there is nothing to push back. Plastic pipe or tiles up to 4in in diameter can be laid by the trenchless method. It is faster, and tidier, when coils of plastic pipe are laid because there is less handling and fewer wheelings.

You can find out more about trenchless drainage in our booklet "Don't Let Water Ruin It".

Please write for a copy to:

F. W. McConnel Ltd.,

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neighbour has drained a field recently and has studied the results.

It is possible that a comparative exercise such as this will show a considerable acreage on the farm to be in need of drainage. The next step is to plan the solution of the problem, stage by stage, dealing first with fields which have the better soils. It may be advisable to discuss the problem with a field drainage consultant or a member of the Agricultural Development and Advisory Service.

Evidence on the surface

The adviser will start his investigation into the drainage status of the field by first considering the farmer's evidence of use and yields. He will also study the field surface for signs of ponded water, crop failure, water-loving weeds, and differences of soil or crop colour etc.

The investigation would then extend to establishing the condition of the ditches serving the fields and of any existing underdrainage systems. Ditches have the function of collecting and conducting surplus water away from the area and into the river systems, of holding down the water table, and of providing out-falls for the underdrainage systems. Unless these channels are capable of doing this work efficiently any other drainage measures are likely to fail. If the channels are in a neglected state and existing outfalls submerged, then the restoration of the ditches may be all that is required.

If the existing underdrainage system in the field is choked with silt or is found to be in poor condition, then improvement of the ditches will not be enough. It will be necessary to open up the system here and there and assess its condition. If the pipes are blocked, or the layout is poor, the drains are too shallow or too deep, or are embedded in a poorly structured clay which prevents the water reaching them, then reconditioning the system will not be the answer. In any case, reconditioning work is very time-consuming and costly and unless a further life of at least fifteen years is assured it should not be undertaken.

Evidence from the soil

The next step is to take auger borings in different parts of the field to establish the nature and the texture of the subsoil and the degree of uniformity within the field. Soil profile pits need to be dug in order to reveal representative soil profiles for inspection.

If surplus water is not to accumulate on the field surface it must be able to descend into the subsoil and naturally disperse at lower levels, or be collected and drained away by a suitably designed underdrainage system. In a sandy soil on a 'shedding' site there is seldom any difficulty, but in heavy soil the movement of water depends on soil structure. Where the individual soil particles are aggregated into distinct clods or 'peds' with good fissures between them, then water movement will be satisfactory. But if the soil is without sufficient fissures or pores, water will have difficulty in moving to the underdrains. Further useful evidence can be obtained from the profile by an examination of the soil colours which can also indicate drainage conditions. It would take too long to describe here the details of a full soil profile diagnosis, but information on this subject is to be found in the recently published Strutt Report *Modern Farming and the Soil**. Suffice to say that as a general

**Modern Farming and the Soil.* Agricultural Advisory Council. H.M.S.O. (£2·10 net)

rule profiles in a well-drained soil exhibit uniform brown or brownish shades, whereas poorly drained soils usually show dark, grey or bluish tones with colour mottlings indicating variations in water table level.

Summary

To establish drainage status it is necessary to consider:

Evidence of field usage and crop yields.

Evidence obtained from an examination of the field surface.

The ditch and arterial drainage system serving the field and the area.

The information obtained from an examination of the soil and subsoil profile.

If the above enquiry reveals that the field drainage system needs improvement, then the information will be useful in designing the necessary works.

All that remains to be done is for the design of improvement works to be completed and an application for grant aid to be submitted. After Ministry approval, a reliable contractor is required to carry out the work; later, the cost, less grant, has to be met. Many farmers would say that this last item is the most difficult. But if the difference in yield between the well drained and the poorly drained field is assessed, a good idea whether the outlay is worthwhile is obtained. If the increase in yield is likely to be at least an extra ½ ton of cereals or 2 tons of potatoes or, for grassland, an extra 100 cow/days of grazing per acre, then the cost will be rapidly recouped and all that is needed is the farmer's faith to see it through.

Remember the Bees when you Spray

Bees are valuable pollinators and their presence can substantially increase yields of fruit, beans, and certain of the brassica seed crops.

However, bees and other beneficial insects can be killed by the thoughtless use of orchard and crop sprays. In their own interests, farmers, fruit growers, spraying contractors and beekeepers should co-operate during the spraying season to ensure that bees are never unnecessarily exposed to danger from spraying.

A little thought by farmers and spraying contractors can prevent losses. The use of the less harmful types of insecticide—granular forms where possible—can help, as can the adoption of the following precautions:

DO NOT use insecticidal sprays or dusts on open blossom in orchards or on crops in flower;

DO NOT apply weed-killers to weeds in flower;

DO NOT dump waste chemicals or used containers in ponds, waterways and ditches which bees may use as drinking places;

DO apply sprays which are toxic to bees early in the morning, or preferably in the evening, so as to give longer for dispersal before the bees become active;

DO avoid spraying in strong wind when spray may drift on to hedgerows or adjacent fields where bees may be foraging (this is especially important when spraying is carried out from aircraft);

DO always observe directions and warnings given on labels of containers of chemicals.

Beekeepers should protect their bees by asking neighbouring farmers and fruit growers always to give them adequate warning before spraying takes place, and by reminding them of the danger to bees by the spraying of fields in their flight path to more distant crops.

Early morning scene at Smithfield Market

Smithfield Market

Ronald Webber

SMITHFIELD—or to give it its official title, the London Central Markets—celebrated its centenary in 1968, for just a hundred years before that date the two buildings which form the original meat market were opened. Additional sections were added between 1870 and 1899 and it is now the largest and most renowned market of its kind in the world for both meat and poultry.

Smithfield past

Although 1868 is the date of the erection of the main market buildings, Smithfield has been the scene of trading for over eight centuries. The great St. Bartholomew's Fair was held there during the month of August for over 700 years. This was the most important cloth fair of the Middle Ages and from the sixteenth century became a pleasure and general trading fair. At one time Smithfield was also a place of public executions and of burnings at the stake; during just four years in the sixteenth century, two hundred people were burnt for their religious beliefs. It was there, too, in 1381 that Wat Tyler, the rebel peasant leader, was slain by Sir William Walworth, the Mayor of London, in the presence of King Richard II.

In 1174 the clerk to Thomas à Becket, one Fitzstephen, described the area as 'a smooth field where every Friday there is a celebrated rendezvous of fine horses to be sold, and in another quarter are placed vendibles of the peasant, swine with their deep flanks, and cows and oxen of immense bulk'. The place was, in fact, known for many years as 'Smooth-field' and was a plain, grassy space just outside the city walls. Of the cattle sold there some

early prices include oxen in 1305 at 5*s.* 6*d.* each, a bullock in 1344 at 16*s.* and cows and pigs in 1354 at 12*s.* each.

Two ancient guilds—the Worshipful Companies of Butchers and Poulters—are connected with Smithfield. In the reign of Henry VIII, butchers' charges were controlled, the maximum for beef being a halfpenny a pound and mutton a halfpenny and one half-farthing a pound.

In 1638, under Royal Charter, the Corporation of London established a cattle market on the site though such a market—with the right to take tolls—had existed by a charter of 1400 and cattle trading, as we have seen, had been carried out there since the twelfth century. The seventeenth century market with its shambles and meat shops in adjacent streets was known as Newgate Street Market, but it became such a nuisance that in 1855 it was moved to Islington where it became the Metropolitan Cattle Market. It was in the market square at Islington that the famous pedlars market—the 'Caledonian'—was held until 1939; that was more or less the successor to the ancient St. Bartholomew's Fair, although the Caledonian was held throughout the year.

The Market today

Today, Smithfield Market is owned and controlled by the Corporation of London, who are responsible for the preservation of law and order, the upkeep of buildings and the general cleansing. This management is in the hands of the Central Markets Committee and administered by the Superintendent and his staff. The market has its own small police force and its own public house with special licensing hours.

Situated in the Ward of Farringdon Without, the market occupies some ten acres with adjacent cold stores which hold several thousand tons of meat.

About half the meat handled is home-killed; the remainder comes from New Zealand, Argentina, Australia, South Africa, Eire and other countries. A large proportion of the home-killed meat is consigned to the market wholesalers by producers and dealers to be sold on commission, but the imported meat is more often bought and re-sold by the wholesaler on his own account. The home-killed comes in daily from abattoirs and poultry packing plants, while the imported is brought from cold stores or direct from vessels discharging at London docks. It is delivered during the night and 'pitching', that is unloading, at the thirty entrance gates is usually completed by about 5 a.m.

There are really three markets in one—veal, poultry and general—trading Monday to Friday from 5 a.m. to 1 p.m. The buyers may go in person to the market, employ an agent, or place their orders by telephone direct to a wholesaler. Buyers can collect the meat themselves or can use a carrier to collect and deliver. Those with their own transport normally use the services of a self-employed porter (a 'bummaree') to carry the meat from the market stalls to the vehicles.

Being a supply and demand market, prices can vary from day to day and even from hour to hour. A bulletin, the *Smithfield Daily Report*, gives the maximum and minimum prices of the produce in season and shows the volume passing through the market.

In 1958 the entire poultry section of Smithfield was burnt down but it was replaced in 1963 with a new hall at a cost of £2 million and known as the Poultry Market, although it accommodates meat traders as well. It incor-

porates cold storage, office and changing facilities, and automatic ventilation supplying cleaned air.

Two years later, in 1965, the rebuilt Fish, Fruit and Vegetable Section came into operation as a general purpose hall with a parade of retail shops.

Prices and Incomes Board report

In 1969 the National Board for Prices and Incomes looked at the remuneration of workers in the market; among other things it said that modernization was urgently needed if the problems of change facing the market were to be overcome. It pointed out that although Smithfield handled over 10 per cent of the total United Kingdom wholesale supplies of meat and poultry, its throughput and share of meat was declining, though poultry had increased rapidly since 1958. However, the market, according to the report, remained very important as a barometer of meat prices both in Britain and abroad.

The Board suggested that a comprehensive study should be undertaken which would take into account both the role and long term economic prospects of Smithfield and the methods of operation of the market as a whole. It also suggested that all parties in the market should accept that matters in which they had a common interest, including the various systems of payment in force both for employed and self-employed workers, should be considered jointly. It recommended the creation of a Joint Board which would be charged with determining the pay and conditions of employment of all workers in the market in a single comprehensive agreement.

The Central Markets Committee of the Corporation accepted most of these recommendations. It disagreed that no study of future trading potential had been made, for in fact the Corporation had done a great deal of research into this as well as commissioning a report by the Economists' Advisory Group which had studied the throughput of all the City markets. It commented on the Board's misgivings being based upon the feeling that it must be wrong to use handling methods introduced a century ago with no clear plans for change in mind. Many changes had been made which stemmed from trade changes such as freezing of poultry and their packing in cartons and the handling of more 'boned-out' meat. The Committee was convinced that changes could and would be made in methods of handling and trade patterns, but it was conscious that the primary function of the market was to serve both consignors and purchasers of produce in the manner and at the cost best suited to them.

The Committee did accept the Board's recommendations on labour relations which involved pay structures, training and pensions schemes, but stressed that 'no amount of enthusiasm . . . will produce results without the co-operation of management and unions and a genuine will on their respective parts to find reasonable solutions to their problems.'

Parking problems

First steps towards implementing the parking recommendations came into operation last year when on 17th July the Lord Mayor unveiled a plaque at Smithfield to mark the transformation of the old railway freight depot into a £500,000 vehicle park accommodating some 450 cars. Up to the last war there had been a flourishing goods depot beneath the meat markets and much of the produce had been brought up in hoists direct from railway wagons to

the market halls. With the increase in road transport, the depot had become obsolete and the Corporation had taken over the lease.

The new vehicle park is managed by the National Car Parks and although market vehicles have priority it can be used also by the public during market off-peak hours. It is divided into three self-sealing bays and is provided with the latest mechanical ventilation plant, fire protection equipment and escape staircases, air ducts and smoke extractors. A novel feature of the development will be a hostel for long-distance lorry drivers which will have forty-eight bedrooms, a snack-bar and a restaurant and will be linked directly with the vehicle park; it is hoped the hostel will be completed by the end of the year.

The next step in the Corporation's traffic improvement scheme is to put stricter control on private parking during market hours, and it is felt that this, together with the new vehicle hall, will do a great deal to relieve the traffic congestion which for so long has been a serious problem in this area.

Other improvements are also being looked at, for the Corporation of London is determined to keep Smithfield in its proud position as the world's foremost meat market.

Ronald Webber is a well-known author and journalist. His article about Spitalfields Market was published in *Agriculture*, January, 1971.

Farm Safety Poster Competition

Every year many children are the victims of accidents on farms, frequently as a result of apparently harmless games or natural curiosity, coupled with lack of supervision. Last year twenty-four young lives were lost in this way and in addition many children were injured in varying degrees, some being seriously maimed for life.

To try to make the public, and particularly children, more aware of the dangers the Ministry of Agriculture, Fisheries and Food, in collaboration with the Royal Society for the Prevention of Accidents and with the co-operation of local education authorities, is organizing a Farm Safety Poster Competition for schoolchildren similar to that held in previous years.

The theme of the competition will again be accidents to children, and six subjects have been given for guidance. These are drowning; being run over by a tractor or other farm vehicle; fires; falls; goring, kicks or other injuries by farm animals; and poisoning. It is hoped that so far as possible the children will be allowed to think out and develop their own ideas within this range of subjects.

The competition will be divided into two classes, under twelve and twelve years and over, and prizes will be awarded for the best posters in each county. The Royal Society for the Prevention of Accidents will award framed merit certificates to the schools who have county-level prizewinners in each of the two age groups, and the best posters from all parts of the country will be judged for national prizes. Prizes for the children will be in the form of Premium Bonds or National Savings Certificates and the schools concerned will qualify for a cash prize, to be spent at the Headteacher's discretion.

The national prizes will be as follows:

	First		*Second*		*Third*	
	Pupil	*School*	*Pupil*	*School*	*Pupil*	*School*
Under 12 years of age	£10	£20	£5	£10	£3	£6
12 years of age and over	£15	£30	£10	£20	£5	£10

Further information about local arrangements can be obtained from the Regional and Divisional Offices of the Ministry.

Livestock in Rumania

E. R. Bullen

RUMANIA, although much the same size as Britain, has only about 35 per cent of our population. In spite of recent expansion of industry, agriculture still employs over half the population and contributes nearly 30 per cent to the gross national income. It is also a major contributor of foreign currency through exports. Since the mid-1960s, a number of very large animal units have been developed, some of which I had the opportunity of seeing during an exchange visit to Rumania last year under the auspices of the British Council. An account of horticulture in Rumania by my colleague, F. W. Shepherd, appeared in the November 1970 issue of *Agriculture* and, like him, I found much of interest to see.

State farms

Most of Rumanian agriculture is on state farms and agricultural co-operatives. There are some private farmers, mostly owner-occupiers, situated in the mountains, and the workers on co-operatives are allowed to have a small amount of private land. The spearhead of recent agricultural development undoubtedly has been the state farms, which appear to have had preferential treatment for supplies of capital and technical expertise; almost all the large livestock units have been situated on them so far.

Arable crops as feed

As in other Southern European countries, grassland, apart from natural mountain pasture, is unimportant in livestock husbandry. Most ruminants were housed intensively and fed on the produce of arable land. The most important arable crops are maize and wheat; barley, sunflowers, soya beans, sugar beet, potatoes and lucerne are also grown extensively. The arable potential of Eastern Rumania impressed me now that the serious summer moisture deficits are being remedied by irrigation schemes. The tremendous scale of these was impressive, one recent project using water from the Danube to irrigate ½ m acres in an area where trials suggest that maize yields are likely to be increased by about 50 per cent. Crops like soya beans and lucerne will also become economically feasible now that water is available.

Pigs

The large scale pig enterprises impressed me particularly, with twenty-three major pig units each producing at least 100,000 fat pigs annually. The largest unit visited had a breeding herd of 9,800 sows, producing about 150,000 fat pigs per annum. Apart from these major units, there were many

so-called 'small' units on both state and co-operative farms of up to 600 sows.

Each major unit comprised a securely fenced compound within which three groups of buildings were situated; these housed breeding stock, weaned pigs and fatteners. Each group was separated from the others by 200–300 metres of land, usually planted to lucerne or fruit. Buildings were elaborate by our standards, but they had to be constructed to operate in sub-zero temperatures in winter and also to cope with summer temperatures well over 30°C.

The obvious question which units of this scale pose is that of disease. I was repeatedly assured that disease problems could be controlled, given efficient management, with particular emphasis on hygiene. Each large unit had a veterinary graduate in the management team. The hygiene practised was extremely thorough; access to the compound was possible only at one point and visitors were required to wear overalls and galoshes. All houses were very thoroughly disinfected between batches of pigs; animals transferred from one section to another were given an extremely thorough washing. The breeding stock were produced in specialized breeding units and this was held to be essential to avoid introducing disease.

Pregnant sows in the pens of the breeding unit at Peris

Effluent Disposal. The problems of effluent disposal seemed less serious in practice than I had anticipated. The effluent, plus some washing down water, was pumped from the pig houses through underground culverts to large lagoons sited well away from the buildings. The high evaporation during the summer months was sufficient to dry out the material to a sludge which, after harvest, could be handled as a solid and spread on arable land. Units of this kind were situated on state farms with very extensive areas of arable land.

The breeding unit. In the breeding unit, served sows were kept in pens, normally in groups of between thirty-five and fifty. These pens had outside yards for use in suitable weather, were well insulated, had forced draught ventilation and could be heated in winter. No dry sows were seen kept in sow stalls and, from enquiries, there was nothing to suggest that such stalls were used. Each group of sows normally farrowed within about two days and the group was of a size sufficient to fill one section of the farrowing house. Farrowing

took place in crates but sows were released from these for feeding. The piglets were weaned at thirty-five days and after weaning the sows were run as a group with a teaser boar and then mated, normally by natural mating, twice on successive days. It was curious to see large groups of boars being kept together but I was told that this presented no problems if they had been brought up together from weaning.

The 'weaner pool' pens and fattening accommodation appeared fairly conventional but artificial heat did not seem to be provided for the fattening pigs.

I formed the impression that the major problems in running such a unit was logistic; it would not seem practicable to hold much feedingstuff at the unit and delivery of the enormous quantities required must have taken considerable organization. Most of the food was grown locally, the cereals being stored, milled, and mixed with protein and minerals in silos situated at strategic points. Both food and fat pigs had to be transported considerable distances in some cases and regular transport, especially in winter, must be a major problem.

It was disappointing not to be able to find more precise information on efficiency standards. The management of the units was clearly far more concerned with production than productivity, and their targets and, incidentally, bonus payments were geared towards encouraging output. It must be remembered, of course, that under their economic system, with prices and marketing state controlled, conventional economic efficiency is not necessarily relevant.

Outside yard accommodation for pregnant sows

Beef cattle

The two beef units visited produced about 10,000 and 22,000 fat cattle annually. Almost all the animals were uncastrated bulls, brought in either as ten-day calves to be fed on milk substitutes until weaning at two months, or older animals weighing about 180 kg which were put immediately on to a concentrate diet supplemented by hay or lucerne. In contrast to the pigs,

which were almost always Large White or Landrace, the cattle were a remarkable mixture of breeds, due to a number of local breeds having been crossed with different bulls. To my eye, only the Simmental and Friesian crosses had good enough conformation to justify feeding as beef animals if the concentrate diet was valued realistically and the price of beef was comparable with ours.

All the beef cattle were housed on slatted floors. The slats had convex upper surfaces and there seemed to be considerable foot trouble which I suspect could have been reduced by using better designed slats. The bulls were normally slaughtered at about thirteen months, weighing about 360 kg. If labour and space permitted, performance was improved if the animals could be tethered from about nine months old, partly due to the reduction of foot troubles. The impression was that the major problems were the supply of sufficient calves of reasonable quality and, of course, that of organizing feedingstuff supplies on the scale required.

Dairying

Most of the dairy units visited kept their own cows in fairly conventional byres; they were tied by the neck, apart from an excercise period each day when they were released into an adjoining earth-floored open yard. Some units were new herds, in which the byres being built were to accommodate 200 cows each, milked by bucket plants. Since Rumania now has nineteen herds of over 2,000 cows each, I was surprised to find so little interest in loose housing and parlour milking; there does not seem to have been a continuation of the policy of the much publicized 30 December State Farm which had a 1,000-cow dairy, cubicle housing and milking by rotolacter. In fact I detected a feeling that the very large units could well be above the optimum size for dairy herds. It was apparently felt that the problem of conserving sufficient fodder became extremely difficult as herds expanded above 1,000, in spite of the relatively predictable climate and the resources of machinery and labour available.

Dairy cattle of the local Dobruja Red breed

Sheep

The sheep industry, until recently, concentrated on producing wool, ewe milk (for cheese making) and lamb skins of astrakhan type. In recent years demand has increased from the Middle East for fat sheep, and a number of intensive feeding units have been set up. The unit visited marketed 40,000

fat lambs per year, all uncastrated rams, fattened during the summer in very cheap buildings with slatted floors. Since sheep were not fattened during the winter, there was no need for elaborate insulated accommodation. Ram lambs were brought to the unit about three weeks after weaning, weighing about 17 kg and were normally sold at 35 kg liveweight. Because of the increasing importance of good conformation, artificial insemination was extensively practised in sheep flocks, using rams of better meat potential than the local breeds.

Impressions

In such a hasty tour, impressions may be unrepresentative but I could not but be impressed by the tremendous scale of the intensive livestock enterprises and the development which has taken place over little more than five or six years from the time the decision was taken to expand such units.

What I had not expected was the very real interest in Britain among the Rumanians. This was partly because much of our equipment was used in their country; we have contributed a great deal to their irrigation developments, for example, and the new Gloria combine, which they had just put in production, was powered by a British diesel engine. Their interest, however, was much wider than just agriculture; for instance, the Rumanian is as much a football enthusiast as we in Britain, and it was perhaps a little tactless of me to visit Rumania just after we had knocked them out of the World Cup!

E. R. Bullen, B.Sc. is the Deputy Director of Experiments with A.D.A.S., London.

Farming in Warwickshire

To anyone interested in agricultural Warwickshire the book *Warwickshire Farming** is of undoubted value.

It contains a comprehensive history of farming in the county during the last thirty years and discusses the way in which its agriculture has developed during that period into a large, complex industry. Although Warwickshire is small and compact it is an area of great farming contrasts. The book describes the many different types of farming, including the way in which factors such as soil types, rainfall and proximity to large cities have influenced the establishment of farms in the county. All aspects of farming are discussed, from the size of farms, their management and the labour employed, to the crops produced and their marketing.

One section of the book is devoted to horticulture—its development and role in the economy of the county. Other sections give details of the history and aims of the various agricultural and horticultural research centres in Warwickshire, including the Drayton Experimental Husbandry Farm and the National Agricultural Centre at Stoneleigh. The authors analyse not only the changes in agriculture which have taken place since 1939 but also give a critical appraisal of the present situation of farming in the county and try to establish the pattern likely to emerge in the future.

*Obtainable, price 37½p (by post 44p), from the Ministry of Agriculture, Fisheries and Food (Publications), Tolcarne Drive, Pinner, Middlesex, HA5 2DT.

A Year in the Life of a Slurry Compound

J. M. Kindell, *A.D.A.S., Oxford*

MR. I. C. HENRY, the owner of Chivery Hall Farm in Bucks, decided to concentrate on milk production on his farm of 60 acres on a flinty clay in the northern part of the Chilterns some 30 miles from London. As the dairy buildings were out-dated and unsuitable for a herd of sixty Friesian milkers certain improvements were necessary. In 1968 a proprietary make of cubicle house which included a double-sided feed area was erected to accommodate the herd and an existing cow-shed range was converted into a 4 point 8-stall herringbone parlour. Bedding of the cubicles is with sawdust and winter rations include hay and brewers grains.

Although the new layout worked well, slurry disposal was a problem because of the difficulty of spreading the manure on to the land during the winter. It was, therefore, decided to provide for a full winter's storage of slurry by the excavation of a storage compound at the southern end of the cubicle building, where there was a convenient area of sloping land.

Construction

An area about 90 ft long and 66 ft wide was excavated to an average depth of 2 ft which produced sufficient flinty clay material to form the side and end walls. These walls were roughly triangular in shape, about 10 ft wide at the base, and rose 5 ft above existing ground level, except that the end wall was a little higher on account of the slope of the ground away from the buildings. This slope was maintained in the floor of the compound and made it possible to store slurry to an average depth of 3 ft 6 in to 4 ft when full. The compound was completed in two days by a contractor at a cost of £36. The siting of a manure ramp jutting out into the compound and costing about £50 completed the project and helped the speedy and efficient removal of slurry from the cubicle building. These costs do not, however, allow for the provision of a simple form of protective fencing round the compound, a necessity in most cases as a safety measure. Washings from the parlour and dairy and polluted run-off from the collecting yard drained to a small catch pit which needed frequent emptying. As an experiment, the contents of this tank were pumped into the storage compound for most of the following winter by means of a diaphragm pump coupled to a long length of flexible hose.

Emptying

Over the winter period (1969–70) the compound filled to the point of overflowing but in spite of the high proportion of liquid which was evidently in the compound the walls stood firm. There was, however, some seepage of

liquid through part of the end wall but this was insufficient to endanger health or to pollute water courses.

In the following September a contractor was hired to empty the compound and spread the contents on to the land. This was done by first removing the slurry from the compound by a Drott (track layer) fitted with a front mounted scoop into conventional rear emptying manure spreaders. Access to the compound was made through a breach in the end wall. However, more liquid than had been expected was found in the compound and it was necessary to pump some of this out before work could start; even so the material handled by the Drott was of a decidely 'soupy' nature. Emptying was completed in two days at a cost of £120, which included some rebuilding and remodelling of the walls to make all ready for the following winter, but this was, to some extent, offset by reduction of labour costs during the winter months.

Summary

1. The disposal system was reasonably cheap to install, operate and maintain and it avoided the daily or weekly chore of manure disposal in the winter. It seems essential to use a track layer for emptying this type of compound unless all or part of the floor is concreted to enable access by wheeled farm tractors.
2. Emptying the compound would have been a simpler job if the parlour washings etc., had been disposed of elsewhere e.g., to a blind ditch. For this reason, in future, only slurry will be stored in the compound.
3. No smell, fly or other nuisance arose during the period of storage in the compound. On emptying, the smell, although powerful, was of limited duration. Some difficulty was experienced through sloppy manure escaping from the rear of the spreaders on to the public roads. The use of a more enclosed type of machine could have avoided this hazard.
4. The amount of percolation into the subsoil appeared to be negligible on account of the clay-based subsoil forming the floor of the compound. For the same reason there was thought to be no ingress of ground water.
5. In calculating the storage capacity of a slurry compound it seems prudent to err on the generous side; half a cubic yard per cow per week for the winter housing period is a useful guide.

Getting Down to Drainage

The latest leaflet to be published in the series *Getting Down to Drainage* is No. 3—Drainage Advice.

In preparing a drainage scheme it is important for the problem to be properly diagnosed and a correct solution determined. Every drainage problem is different and the purpose of this leaflet is to draw attention to some of the more important points which must be examined.

Single copies of the leaflet may be obtained, free, from the Ministry of Agriculture, Fisheries and Food (Publications), Tolcarne Drive, Pinner, Middlesex HA5 2DT, or from any Divisional Office of the Ministry.

The Malvern Hills

47. Worcestershire

R. A. Engledow

MOST of Worcestershire consists of a central plain with ranges of hills on the borders of the county. The main soil formations of its 344,000 acres of agricultural land are Lias Clay and Keuper Marl, with coarse and fine sandstone formations to the north near the Staffordshire border. The valleys of the Avon, Teme and Severn include very fertile alluviums, but cropping and stocking policies are restricted because of appreciable valley flooding which in the case of the Teme may build up at very short notice. Many Worcestershire soils are above average fertility and this, together with the location of comparatively close markets, has encouraged specialized cropping. Most soil formations need artificial drainage and there is still much scope for improvement in this respect. The lime status of the soil is not a general problem except on the sands and gravels in the north of the county.

Rainfall varies a great deal within the county; the annual average is over 31 inches in the hilly districts in the north and west, but 6 inches less in the central and southern parts.

Differences in elevation, aspect and soil type are of considerable importance to market gardeners and fruit growers in the county. For example, the fruit trees at Evesham blossom 14–20 days earlier than in the more northern districts because of the better aspect, more sunlight hours and less wind. Vegetable growers have not been slow to exploit these phenomena by very early spring planting and sowing, well knowing the risks they are taking. Outdoor crops of runner beans and early summer cauliflowers are planted

out up to a month before those elsewhere in the county; usually the crops succeed, but sometimes frost makes replanting necessary.

Crops and grass

The total area under crops and grass amounts to 333,000 acres of which just under one third is used for cereals. Maincrop potatoes occupy about 4,000 acres. Increased mechanization for sugar beet production has led to a 50 per cent acreage increase over the past four years to about 7,000 acres; the crop is processed at Kidderminster. Temporary grass acreage is about 40,000 and permanent grass, which has fallen steadily over the years, covers 150,000 acres. Much of the grass is found on flood meadows, Lias Clay and low lying areas. In addition, higher land on the perimeter of the county is too poor and banky to be ploughed. The area devoted to vegetables and fruit also continues to fall and is now 28,000 acres. There has been a spectacular acreage drop in farm orchards.

Livestock

Milk production is the most important enterprise. The total dairy herd, which is predominately Friesians, has been constant at about 27,000 for some years but fewer herds are kept. As might be expected the Hereford breed or its crosses dominate the grazing herds and many farms both rear and fatten stores for most to be finished at grass. An established calf marketing group is a great help.

The sheep population was over a quarter of a million but has dropped slightly over the past four years. They are mostly Kerry or Clun crosses but various other breeds are being tried. The majority lamb from early February and usually ewes are kept for only two or three seasons; replacements are then obtained through the Welsh border sheep sales. Some noteworthy pedigree flocks of Suffolks are kept and the strains are being markedly improved through systematic progeny recording.

The Evesham District

This highly valued horticultural area lies in the Avon Valley. It developed into its present pattern following the agricultural depression in the 1870s, when landowners allowed former employees to cultivate strips of uncropped fields as smallholdings with market garden produce and later fruit crops being grown for sale in the developing towns and cities of the Midlands.

As the horticultural industry expanded the initial practice of dividing up fields into strip plots ($\frac{1}{8}$–$\frac{1}{4}$ acre) continued, and tenants rented what they could cultivate whenever more land became available. A grower's holding thus became formed from different plots of land, identified by only a furrow in the soil in one or more fields and parishes. Hedges were removed and ditches piped in. Time was lost travelling from one plot to another, but different soil types favoured the wide range of crops grown.

Holdings are let under what is known as the 'Evesham Custom' whereby a tenant who develops his holding under an intensive system and plants it with fruit trees and bushes has the option, at any time of the year, to introduce for the landlord's approval an incoming tenant who will pay the outgoing tenant for the improvements effected. The custom has helped small growers and favoured intensive production. The average holding size is about

7 acres, but double this area is now needed to secure a reasonable income and as a result the amalgamation of holdings is taking place.

Herbs, particularly sage, are grown on both plot and field scale. The industry became firmly established in the 1914–18 war and expanded again during the last war. About 500 acres of sage are grown and practically the whole crop (about six tons per acre) is sold under contract to driers. The more recent expansion in acreage may well be related to the growth of the broiler chicken industry. Considerable thought is being given to mechanical harvesting, but no efficient machine has yet appeared.

Evesham is closely associated with plums, particularly the Yellow Egg variety, but the acreage has diminished in recent years. Modern insecticides, particularly for controlling greenfly, have overcome one of the worst production hazards, but spring frosts sometimes destroy much of the crop.

Hops

Herefordshire and Worcestershire together grow many fewer acres of hops than are to be found in Kent and Sussex. In Worcestershire the crop grows well on the heavy loams derived from the Old Red Sandstone found in the Teme Valley. In other parts of the county the crop is grown successfully on a variety of soils such as river terraces, alluviums, sandy loams and even on heavy Lias Clay. Most West Midlands crops produce above-average yields of about 16 cwt of high quality hops used for the lighter types of beers.

Ministry Publications

Since the list published in the May 1971 issue of *Agriculture* (p. 218) the following publications have been issued.

MAJOR PUBLICATIONS

FIXED EQUIPMENT LEAFLET

No. 47. Sheep Housing (Revised) 17½p (by post 20p)
(SBN 11 240587 8)

OUT OF SERIES

Annual Review and Determination of Guarantees, 1971. Cmnd. 4623
(New) 22½p (by post 25p)
(SBN 10 146230 1)

FREE ISSUES

SHORT TERM LEAFLETS

No. 52. Suggestions for Chemical Weed Control in Vegetables (Revised)
No. 66. Docking Disorder in Beet (with special reference to free-living Eelworms) (Revised)
No. 117. Dry Bulb Onions—Managerial and Economic Considerations (New)
No. 120. Isolation and other Facilities in Connection with the Control of Disease such as Brucellosis (New)

PROFITABLE FARM ENTERPRISE

No. 3. A System for Welsh Mountain Sheep (Welsh Version) (New)

HORTICULTURAL ENTERPRISE

No. 2. Glasshouse Lettuce (New)

UN-NUMBERED LEAFLET

Fireblight on Ornamental Trees and Shrubs (New)

Priced publications are obtainable from Government Bookshops (Addresses on p. 276) or through any bookseller. Single copies of the free items are obtainable from the Ministry of Agriculture, Fisheries and Food (Publications), Tolcarne Drive, Pinner, Middx. HA5 2DT.

in brief

- **Farming under pressure**
- **Slurry is an asset**

Farming under pressure

No one can say that the organizers of the Oxford Farming Conference have any inhibitions about grasping nettles: indeed it is precisely this attribute which continues to make this annual event such an important forum for farming thought. This year's conference lived up well to its established reputation when not one but a whole bunch of nettles was grasped under the generic title of 'Farming under Pressure'. Historically, it would be difficult to find a time when farmers were not under pressure of some kind; it is an in-built liability of the business, and as the natural growth of society embodies more and more sophistications to enable it to function effectively in all its diverse spheres, so new and often stronger pressures make themselves felt. To the political and economic pressures that are incidental to the running of the country's economy at any time, we have today to add those emanating from manufacturing industry's steady invasion of rural areas, expanding social demands on land, inputs of capital necessary to keep abreast of increasing technology and new concepts in specialized production and marketing; and, of course, the reorientation of theory and practice that would be consequent upon membership of the European Common Market.

The speed of urbanization, as Professor A. Goss, of the University of Wales, pointed out, proceeds at even a much faster rate than population increase itself. By the end of this century many nations throughout the world will have something of the order of three-quarters of their populations living in towns and cities, the majority of them in urban units of at least 100,000. In Britain we may expect a population increase of 20 per cent in the next thirty years and a resultant urban impact in the fullest sense of that term on agricultural land as an inseparable corollary. Large-scale industrial plants and processes, such as steel plants, power stations and oil refineries, may also be expected to make further inroads into rural areas. And over and above all this is the insistent demand for the countryside to provide areas for purely recreational and leisure pursuits, together with all the facilities needed to service them. The modern pressure of competition in the use of the land is without parallel in our history, and is particularly heavy because our island is so small.

These are the inescapable facts of national farming life today; nor are they confined to Britain. But under the pressure of a restless technological advance, in which incidentally this country has set a world example, keeping up with its many facets is something that is felt individually. Dr. G. R. Dickson, who farms for the Duke of Norfolk, in Sussex, commented on this. 'As margins decline and capital becomes scarce,' he said, 'the economic justification of applying new technology becomes more critical.' He instanced farm machinery, which is becoming so sophisticated and expensive that even in the face of a seriously diminished labour force it is doubtful whether adequate finance can be found to keep up with developments. Here, too, was a David challenging the Goliath of commercial enterprise and research whose efforts he saw to be directed primarily towards a marketable end product,

so that new technology is invariably associated with increased costs. 'Unless,' he said, 'we achieve a more effective non-commercial research and development structure, with greater awareness of the real problems confronting farmers, the industry runs grave risks of being taken over and exploited by the technocrat, to its lasting detriment.'

Mr. S. A. Hurd, who farms 600 acres in Wiltshire and spoke of the future for the farmer with an average size of holding, rallied the Conference with his call to recognize that farming today is a business requiring all the management skills that are used by other industries and to employ them at a lower salary than his talents might earn him elsewhere. He must be prepared to sacrifice some independence in order to collaborate with others, particularly in the marketing of his produce; and to accept that more is implied in a farmer's responsibility to society than simply the economic production of food.

The publication of the Conference papers and proceedings, which can be obtained from M. H. R. Soper, University of Oxford, Parks Road, Oxford, price 75p, extends the value of this three-day meeting which crystallized some of the problems posed by present-day farming under pressure and ventured some suggestions for their alleviation.

Slurry is an asset

ALMOST invariably to solve one problem is to raise another—which is what one might call the side-effects of progress. A clear example of this is seen in our retirement of the dung-cart in favour of the fertilizer distributor. In the old days, as we are pleased imprecisely to refer to them, the midden was the acknowledged reservoir of soil fertility, and 'slurry' was still only a liquid mixture for making Portland cement! Intensification of livestock farming and stringent legislation aimed against water pollution have continued to make the disposal of the high-organic 'by-products' of animal husbandry a problem of literally expanding dimensions, and particularly so where the numbers of stock have overtaken earlier estimates of the resources necessary to deal with them. Unfortunately, what is often termed 'farm waste' may condition thinking as to its value, whereas sound husbandry requires that it should be returned to the soil for its manurial and conditioning qualities.

There has been no shortage of ideas for disposal systems, from the simple pit and the slurry tanker to sophisticated oxidation plants incurring a heavy capital outlay and high running costs. But in the final analysis, as was demonstrated by the N.I.A.E. at last year's Royal Show, the problem is one that has no universal solution. It has to be resolved by individual assessment of the quantities of manure to be dealt with, planning an effective disposal unit in relation to the number of stock being, or likely to be, carried; a simple and convenient layout of buildings, the method of housing, cropping plan, considerations of mixed stocking, feeding systems and available equipment. Increasing emphasis on the dangers of polluting water supplies, whether through watercourses or soil seepage, must inevitably stimulate new approaches to the slurry disposal problem. Further research in drying techniques may continue to lessen the load on intensive poultry farms, but in dealing with cow and pig excreta refined systems of oxidation already emerging may provide the answer we are looking for. The ultimate goal must be a fertilizing medium that is free from harmful bacteria, e.g., salmonella, is of such consistency as not to make pastures unusable for appreciable lengths of time, and is, in short, welcome as a valuable asset rather than, as at present on many farms, a burden to be shifted elsewhere with all possible speed.

AGRIC

Books

A History of Farm Buildings in England and Wales. NIGEL HARVEY. David and Charles, 1970. £3.

It is perhaps appropriate that this book about the countryside of England and Wales was published in European Conservation Year. The author trained both as a historian and as a land agent; in the latter capacity he specialized in farm buildings, first as a member of the Agricultural Land Service and then for eleven years as Information Officer to the Farm Buildings Unit of the Agricultural Research Council. For some years he edited the *Bibliography of Farm Buildings Research.*

It will thus be clear that Nigel Harvey is well fitted for the task he has undertaken. The story of the development of our farmsteads is unfolded from the primitive longhouse of a thousand years ago to the most modern labour-saving dairy layouts of the past decade. Evidence of the earlier buildings is scant and the first quarter of the book, which deals with the period up to 1750, will probably appeal most to the historian.

The remainder, however, deals fully and fascinatingly with the farm buildings of the past two centuries. Many of these not only punctuate and decorate our rural landscape today and add an essential element to its quality, but they also serve as a museum of country life, much of which is still in active use.

The book will be of special interest to agricultural surveyors and others whose work takes them to many different farms. It can be used as a guide book and it will interpret for them things which they have observed often but of which they may have understood little. It will enrich their work, throwing light on such popular traditional beliefs as that most of our older barns used old ships timbers in their construction.

There is one aspect of the layout of the book, however, which is somewhat irritating. Notes are in abundance and are collected, often fifty to a hundred and more, at the end of each chapter. Some are merely an acknowledgement of the source from which the author has derived his information. Others are lengthy and contain extracts which add to and illuminate the text. The reader can never therefore be certain whether or not to interrupt the narrative to refer to the notes. It would have been much better if many of these notes had been incorporated in the body of the book; perhaps this will be borne in mind for another edition.

J.D.F.

Hydroponics: The Bengal System. (Fourth Edition). J. SHOLTO DOUGLAS. Oxford University Press, 1970. 90p.

This fourth edition of Sholto Douglas's book, first published in 1951, gives an exhaustive account of hydroponic systems with particular reference to that developed by the author in Bengal.

The practical utility of hydroponic systems is without doubt wherever ordinary methods of agriculture and horticulture are impracticable and it is under those conditions that hydroponic methods seem to have been most worthwhile. However, the vagaries of nature give way to planned control of crop production if one reads between the lines of this informative book and a general case is made out for the advantages of thinking hydroponically. In that, I feel the author is inclined to be over-persuasive, but many criticisms of soilless cultivation are faithfully recorded and many logically disposed of.

This is an interesting book which might, perhaps, profit from being recast in a less discursive and more concise form.

A.J L.L.

Weed Control Handbook. Volume 2: Recommendations. (Sixth Edition). Edited by J. D. FRYER and R. J. MAKEPEACE. Blackwell Scientific Publications, 1970. £2·25.

Crop protection is one of the most important and complex technologies in modern food production. There has been a very rapid development in chemical weed control in Britain over the last five years and herbicides now account for more than two-thirds of the large volume of pesticide sales by manufacturers.

The Fifth Edition of the Weed Control Handbook (1968) was presented in two

parts, Volume 1: Principles, and Volume 2: Recommendations. A complete revision of Volume 2 has become necessary within two years, while minor alterations only have been made to a reprint of Volume 1.

The new Volume 2 has been compiled by the Recommendations Committee (Weeds) of the British Crop Protection Council, assisted by a team of experts from official organizations, industry and universities. It is comprehensive and authoritative. The authors are to be congratulated on the successful way in which they have assembled the book from a mass of scientific and technical data.

This handbook will be of considerable use to farmers, growers and their advisers as a practical guide on weed control in crops. It also includes useful chapters on weed control in turf used for sport and amenity purposes, forestry, non-agricultural land, and aquatic weeds. Where evidence is insufficient to make a definite recommendation, the advice is given 'for information'.

Compared with the previous edition, presentation of subject matter in the text and tables has been improved in the new volume. For example, the bolder main headings in the text are easier to follow, the presentation of tabulated data is clearer and references from the index are more readily identified. The Weed Tables in chapter 10 have been condensed to avoid needless factual repetition and in the final chapter attention is focused on important problem weeds.

In the 1970s, future editions of this valuable handbook may have to pay more attention to developments like the multi-stage use of herbicides in crop systems and cost/benefit appraisals.

M.E.

Grassland Ecology. C. R. W. SPEDDING. Clarenden Press: Oxford University Press, 1971. £2.

In the preface the author states 'the book is primarily an attempt to describe what grassland ecology is about'. The book successfully achieves this objective in a manner which is comprehensive of subject matter and comparatively easy to read. In some ways it also successfully achieves the secondary objective of integrating classical grassland ecology with agricultural practice.

The book is written mainly for specialists and should appeal to students and researchers of ecology and the disciplines that impinge upon ecology. There is also something in the book that will appeal to students of agriculture, particularly those seeking a further useful dimension to the study of grassland farming. The multi-discipline appeal is enhanced in that the manner in which the book is written is simple without being elementary.

The first sixty-eight pages relate to the botanical aspects of ecology from the more classical approach. The next eighty-five pages deal, in a most interesting fashion, with grass/animal inter-relationships. The final thirty-three pages are concerned with the agricultural aspects of animal production from grass.

The author, as head of the Ecology Division of the Grassland Research Institute, has a vast personal experience of grassland experimentation. He is also in the fortunate position of being able to draw on the experimental data of colleagues at the G.R.I. As a consequence, much of the text is substantiated by factual evidence. Indeed, the book is somewhat unusual in treating the subject of grassland ecology in an uncommonly quantitative and as a result, interesting fashion. Each chapter contains a well-documented list of references for further reading.

H.D.

Where Beards Wag All. GEORGE EWART EVANS. Faber and Faber, 1970. £2·50.

Change in the countryside is seldom drastic. But it is continuous and pervading and its cumulative effects are dramatic. This book is essentially a series of studies of rural life and work in East Suffolk based on interviews with men and women born in the reign of Queen Victoria. The kind of village society and economy they describe endured until the Second World War but it is now gone, overwhelmed in less than a generation by the forces of the modern world. Mr. Evans knows too much about its hardships and injustices, however, to regret its passing. He records it, generally in the words, and always in the terms, of those who were part of it.

One by one we meet the persons of the traditional village drama—the landowner, unquestioned master of the closed village; the farmer, equally absolute but on a smaller scale; the labourer, dependant, cautious, secretive; the auctioneer; the drover; the

saddler; the village cobbler; the craftsmen of the local foundry. It was a rigidly hierarchical society in which the principle of class distinction was well established. Significantly, the only general form of movement this society allowed was outwards. Mr. Evans spends some interesting pages on the seasonal migration of workers to Burton-on-Trent and the young labourers who, like their Viking ancestors, went to sea after harvest.

He quotes various evidences to show that the oral tradition, which is his main source of material, can cover considerably more than a lifespan but he recognizes that the end of this tradition has come.

As one who saw the last age of the old order in East Suffolk thirty years ago, I can bear witness to the skill, understanding and success with which the author has recorded so many of its memories.

The book is well illustrated with agreeable and evocative contemporary photographs.

N.H.

Agricultural Chemicals Approval Scheme

There are no Additions or Amendments to the 1971 List of Approved Products for Farmers and Growers this month.

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CROP PRODUCTION: CEREALS AND LEGUMES

B. F. Bland
RHM Agricultural Industries Ltd.
Throws Farm, Stebbing,
Great Dunmow, Essex, England

May 1971, xii + 466 pp., £5·00

Productivity in crop farming has improved rapidly with the aid of modern technology. But, to date, no published literature has dealt with cereals and legumes in depth and indeed no recent observations have been made on crop husbandry. This book describes the history, development, botanical classification and utilisation of each crop. The sequence of operations (including all the technical details such as cultivators, fertilisers, seed, sprays, etc.) necessary to their production are fully described. Ample tables and photographs have been supplied to illustrate the various concepts and principles. It is not always possible for students to gain an insight into these arable crops during their brief practical periods spent on farms, and the author's experience as a teacher has enabled him to recognise and overcome this problem. The large bibliography should also appeal to the more academic reader for reference purposes when studying specific aspects of farming.

ACADEMIC PRESS
London and New York

Berkeley Square House, Berkeley Square, London W1X 6BA, England
111 Fifth Avenue, New York, NY 10003, U.S.A.

Bacteriological Techniques for Dairy Purposes

The bulletin contains a useful historical introduction, sections giving the technical details for preparing glassware and bacteriological media and standard methods for the examination of raw and pasteurized milk, milk rinses and swabs of dairy equipment and farm water supplies. The appendices contain recommendations for the application of bacteriological advisory work in relation to modern methods of milk production.
(*Technical Bulletin No. 17*) 67p (by post 74½p)

Grass and Clover Crops for Seed

Describes the origin in Britain of the growing of, and trade in, grasses, clovers and some other legumes for seed and contains sections on the quality and differences in growth and development of herbage seeds, on their usefulness as an economic cash crop in arable rotation and on sowing, management and storage. Chapters deal with weeds in seed crops, both as regards control in the field and the requirements under the Seeds Act; and with the types, effects and control of diseases and pests which may attack crops and reduce yield. Illustrated (*Bulletin No. 204*) 39p (by post 43½p)

A free list of agricultural and horticultural titles is available from Her Majesty's Stationery Office, (P6A), Atlantic House, Holborn Viaduct, London EC1P 1BN

HMSO

Government publications can be obtained from the Government Bookshops in London (post orders to PO Box 569, SE1 9NH), Edinburgh, Cardiff, Belfast, Manchester, Birmingham and Bristol, or through booksellers

Ministry of Agriculture, Fisheries and Food

SELECTED PUBLICATIONS

Dairy Floors

Prepared by a sub-committee of the Milk and Milk Products Technical Advisory Committee, this report will be of interest to everyone concerned with the dairy industry. Architects, builders, plant designers, management and dairy technicians will find it a useful guide to all aspects of dairy floors. The main subjects covered are design; materials available; special considerations for various parts of the dairy; maintenance and repair. It contains a good bibliography. Illustrated.
40p (44½p)

Farm Buildings Pocket-Book

Since the first edition of the Pocket-book was compiled there have been many developments affecting the accommodation of livestock and the storage of produce and materials on the farm. This revised edition gives what are accepted generally as the standards applying today.
17p (21½p)

Commercial Glasshouses

This revised and illustrated bulletin deals comprehensively with the many developments which have taken place since the third edition was published in 1960, a time probably of more rapid change than in any similar period in the history of the glasshouse industry. Choice of site and nursery layout, glasshouse types, construction and materials, are all fully discussed, and in addition to advice on ventilation, considerable attention is given to the requirements of various types of heating systems. (Bulletin No. 115)
63p (70½)

Bulk Storage of Potatoes in Buildings

Discusses the siting, design and construction of buildings for the storage of potatoes in bulk. This illustrated bulletin also deals with insulation and ventilation and the questions of mechanical handling and managing the crop from the time it is put into store until it is marketed. (Bulletin No. 173)
23p (27½p)

Prices in brackets include postage

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Government publications can be bought from the Government Bookshops in London (post orders to PO Box 569, SE1 9NH), Edinburgh, Cardiff, Belfast, Manchester, Birmingham and Bristol, or through booksellers

The Changing Structure of Agriculture

The publication in 1966 of a report on 'The Structure of Agriculture' marked a new stage in the development of agricultural statistics in the United Kingdom and was made possible by automatic data processing of the agricultural censuses. The present report shows that significant changes are taking place and indicates what these changes are.

32½p (37p)

Agricultural Bulletins:

Swarming of Bees

In recent years there has been much research into bee behaviour and swarming in particular has received considerable attention. In this new publication, the Ministry of Agriculture, Fisheries and Food's Bee Group relates the work of research scientists to practical bee-keeping. (Bulletin 206)

22½p (25p)

Beneficial Insects and Mites

Gives an account of certain insects and mites whose activities are of vital importance. These are pollinating insects, and those which live at the expense of other related creatures, also plant feeding insects which have proved beneficial as weed control agents. 8 pp. coloured plates. (Bulletin 20)

85p (90½p)

Strawberries

Provides information on all aspects of growing strawberries including choice of site, cultural operations and marketing, propagation (including mist propagation), cold storage of runners and the certification scheme. (Bulletin 95)

52½p (58p)

Prices in brackets include postage

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